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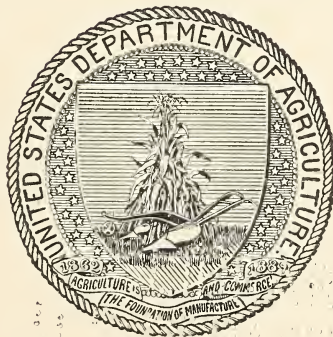
ANNUAL REPORT

OF THE

OFFICE OF EXPERIMENT STATIONS

FOR THE YEAR ENDED JUNE 30,

1909.



WASHINGTON:

GOVERNMENT PRINTING OFFICE.

1910.

JOINT RESOLUTION Providing for printing annually the Report of the Director of the Office of Experiment Stations, Department of Agriculture.

Resolved by the Senate and House of Representative of the United States of America in Congress assembled, That there be printed eight thousand copies of the Report of the Director of the Office of Experiment Stations, prepared under the supervision of the Secretary of Agriculture, on the work and expenditures of that Office and of the agricultural experiment stations established in the several States and Territories under the act of Congress of March second, eighteen hundred and eighty-seven, for nineteen hundred and three, of which one thousand copies shall be for the use of the Senate, two thousand copies for the use of the House of Representatives, and five thousand copies for the use of the Department of Agriculture; and that annually hereafter a similar report shall be prepared and printed, the edition to be the same as for the report herein provided.

Approved, April 27, 1904.

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LETTER OF TRANSMITTAL.

OFFICE OF EXPERIMENT STATIONS,

Washington, D. C., April 30, 1910.

SIR: I have the honor to transmit herewith the annual report of the Office of Experiment Stations, the publication of which is authorized by joint resolution of the Fifty-eighth Congress, second session. This includes a report on the work and expenditures of the agricultural experiment stations established under the act of Congress of March 2, 1887, for the fiscal year ended June 30, 1908, in compliance with the following provision of the act making appropriations for this Department for the said fiscal year:

The Secretary of Agriculture shall prescribe the form of the annual financial statement required by section three of the said act of March second, eighteen hundred and eighty-seven, shall ascertain whether the expenditures under the appropriation hereby made are in accordance with the provisions of said act, and shall make report thereon to Congress.

There is also a report for the same year on the receipts and expenditures and work of the stations under the act of Congress of March 16, 1906, in accordance with section 5 of that act.

Very respectfully,

A. C. TRUE,
Director.

HON. JAMES WILSON,
Secretary of Agriculture.

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ANNUAL REPORT OF THE OFFICE OF EXPERIMENT STATIONS, 1909.

WORK OF THE OFFICE OF EXPERIMENT STATIONS.

The work of the Office of Experiment Stations during the last year has included, as heretofore, the supervision of the expenditures of federal funds by the agricultural experiment stations in the several States; conferences and correspondence with station officers regarding the management, equipment, and work of the stations; the collection and dissemination of information regarding the progress of agricultural education and research throughout the world by means of technical and popular bulletins; the management of the agricultural experiment stations in Alaska, Hawaii, Porto Rico, and Guam; the promotion of the interests of agricultural colleges and schools and farmers' institutes throughout the United States; special investigations on irrigation and drainage, conducted largely in cooperation with experiment stations, educational institutions, and other agencies in different States and Territories; and the investigation of problems relating to the food and nutrition of man.

RELATIONS WITH THE AGRICULTURAL EXPERIMENT STATIONS.

The administration of the Adams Act and the closer restriction of the funds appropriated under the Hatch Act, in order to confine them to actual experimental work and investigation, have commanded much attention during the year.

Many questions of detail continue to arise regarding the projects as submitted or as the work under them is developed. There is still too much latitude, in many instances, in the submission of projects. Projects are frequently proposed by station workers, and referred by the directors to the Office for a decision, which from their character should never have gone beyond the director's office. This is sometimes due to carelessness, and sometimes, it is feared, to a failure to discriminate critically between undertakings which possess merit as investigations and those which are more economic and superficial and do not embrace research features. This has added materially to the

work of the Office, and has thrown the burden too largely upon it of eliminating undertakings which do not properly belong under a research fund. The difficulty of explaining the distinctions of research through correspondence makes necessary a careful scrutiny of the projects and their discussion at the station before they are submitted. It is also found necessary to follow the work under the various projects in considerable detail, and to insist on its being developed along research lines and held to specific studies. This has added materially to the duties of the inspection. It is still too much the practice to permit men whose training and experience do not fit them for good research work to participate in it.

The increasing importance and prominence which various forms of extension work are assuming, and the rapid developments along that line, have raised many questions as to the use of the federal funds, and have made a more strict differentiation necessary between station work proper and the popular demonstration and extension features. This is one of the most conspicuous developments of the year as affecting the supervision of the station funds, and is discussed at some length in the report on work and expenditures (p. 55).

The need of a better system of publication of station work is growing more urgent. The present mixture of scientific and popular material, compilations, inspection tests, and analyses becomes more and more confusing and unsatisfactory to farmers and scientists alike. It is hoped that as the extension departments are organized they will take from the stations the great burden of compiling bulletins and of miscellaneous routine correspondence.

A way should also be found to publish separately the detailed records and results of the scientific work of the stations. In many places valuable data are being accumulated and stored up because no feasible method of publication has been found. The practice is rapidly growing of publishing brief accounts of the scientific work of the stations in a great variety of scientific journals at home and abroad. As one means of disseminating information regarding this work such publication is a good thing. It can not, however, take the place of a full publication of the scientific work of the stations.

Such scrappy and scattered publication gives a very inadequate record of what the stations are doing in advancing knowledge, and produces very little impression of the real services of the stations as public scientific institutions. The whole tendency of such a system is to build up the scientific reputation of the individual officer at the expense of the institution which he serves. A method of publication is needed which will bring together the scientific work of the American stations, so that the world may know what these institutions endowed with federal and state funds are really doing to ad-

vance the science of agriculture. A great national system of research along agricultural lines is actually established, but at present this is almost wholly obscured by the confused and inadequate method of publication of the scientific work of the stations. The need of a better system grows more urgent with every year's advance of research under the Adams Act. It is therefore earnestly hoped that this matter will receive serious consideration at an early day, and that active measures will be undertaken to remedy this glaring defect in the system of scientific inquiry on behalf of agriculture.

The work which is being done by the experiment stations abroad is not only of general interest to similar workers in this country, but much of it is applicable to American conditions, either directly or with modification. Through its relations with the foreign stations the Office is in position to follow this work with increasing completeness and to keep informed upon the progress of other matters relating to these institutions. A quite large number of periodicals and documents describing their investigations are now received in exchange for Experiment Station Record, and this has enabled the office to become a clearing-house for the foreign work as well as that of the American stations.

INSULAR EXPERIMENT STATIONS.

A prosperous year is reported from each of the insular stations, and the work of all is developing as rapidly as the resources will allow. As a result of increased appropriations, new lines of work have been taken up by the Hawaii and Porto Rico stations, and in Alaska an effort is being put forth to develop the Fairbanks Station on a sufficient scale to demonstrate the possibility of farming as a vocation in that country.

The work of the insular stations has been continued along the lines described in previous reports. The policy of conducting investigations to bring about diversification of agriculture has been continued as the most profitable one to pursue where agriculture is only slightly developed, as in Alaska, specialized as in Hawaii and Porto Rico, or primitive as in Guam. This policy requires much attention to the introduction of new crops and the demonstration of their adaptability and profitableness in the new regions. While much of the work at each of the insular stations is of an elementary nature and is conducted with the idea of visual demonstrations, yet at the same time fundamental problems are being given attention and some of the work is of high scientific value.

The various bureaus of the Department have been quite generous in their assistance to the insular stations and it is desired to acknowledge their cordial cooperation at this time.

The administrative business of this Office in its relations with the insular stations has as hitherto been in charge of Dr. Walter H. Evans, chief of the division of insular stations. The character and scope of the work carried on by the different stations may be seen from the summaries presented below.

ALASKA STATIONS.

The climatic conditions in Alaska during 1909 were not so favorable for agriculture as in some previous years. Along the coast region the rainfall was heavy, cloudy days numerous, and the temperature rather lower than normal. The same conditions to a less extent were noted in the interior, where the actual rainfall was not large but the proportion of cloudy days was unusual.

The work at these stations continues along the lines described in previous reports, horticultural investigations being given prominence at the Sitka Station, grain growing at Rampart and Fairbanks in the interior, and stock raising on Kodiak Island.

The most important change in the affairs of the Alaska stations has been the temporary closing of the Copper Center Station. This was decided upon for several reasons, among them the isolation, which made transportation of supplies very expensive; insufficient rainfall, only 0.5 inch during April, May, and June of 1908; early frosts, due to the proximity of the high mountains; and the desire to develop the Fairbanks Station, where conditions are believed to be more favorable and where a larger population has already become established. The Copper River Valley has not become settled or developed as rapidly as was expected when the station was opened there in 1902. The station, which was then located at Copper Center, has been maintained for six years, and about 40 acres of land were brought under cultivation and some success was attained in growing cereals—crops of wheat, oats, and barley maturing in favorable seasons, while in other years practically all grains were lost, due to early frosts. The possibility of growing hardy vegetables in the Copper River Valley was fully demonstrated by the experiments carried on at this point, and it seemed necessary to close this station in order to open one in the rapidly settling region of the Tanana Valley. The appropriations would not permit of maintaining two stations, and as a consequence the greater part of the implements and movable equipment was transferred to Fairbanks and the lands and buildings temporarily turned over to the Bureau of Education of the Department of the Interior. It is expected that some simple demonstration work will be conducted by the Bureau of Education, and experimental work can be resumed whenever it is believed wise to take up work again in that locality.

At Sitka the test orchard now contains 46 varieties of apples. A few of these have bloomed during the past two or three years, but have set no fruit. It appears doubtful if apples of any of the existing varieties can be brought to maturity in Alaska. Attempts have been begun to develop hybrids of the native Alaska crab apple, and a number of crosses have been made between this and some of the cultivated varieties of apples, but it will require several years to obtain definite results from this hybridization work. The experiments with bush fruits were continued and show that currants, gooseberries, and raspberries do exceedingly well along the coast region. The hybrids made between the salmon berry and the cultivated raspberry have grown, but so far have not borne any fruit. The strawberry hybrids produced by using the native wild strawberry as the staminate parent and a cultivated variety that was found growing at Hollis, Alaska, have borne fruit, some of which is of most excellent character. Of the 2,000 hybrid plants produced, 1,288 have bloomed and notes have been taken upon their character. The fruit produced in many instances had the size and other desirable qualities of the cultivated variety, while they also were characterized by the fine flavor and aroma and firmness of the native berry. The experiments with potatoes and other vegetables were only a moderate success, due to too much rain and a lack of sunshine. Partial crops, however, of potatoes, cabbage, cauliflower, carrots, turnips, and beets were produced.

The work at the Rampart Station has given the usual satisfaction. Out of something over 60 varieties of cereals, 1 variety of winter wheat, 1 of spring wheat, 7 varieties of winter rye, 29 of spring barley, 15 of spring oats, and 1 variety each of spring emmer and spring rye matured their entire crop. Some other varieties of cereals matured a portion of their seed, which was saved for future planting. Two varieties of buckwheat were considerably injured by frost, but a small percentage of the seed ripened. This season's results are in line with those of the past eight years and show that grain can be brought to maturity in the Yukon Valley without serious liability to failure. Sixteen acres of land are under cultivation at the Rampart Station, and this area has been increased by clearing and preparation so that there will be 22 acres under crop next season. The investigations at Rampart as well as in other parts of Alaska have shown the necessity for properly preparing the soil and the thorough removal of moss, otherwise the first crops will be very poor. Wherever the moss is burned off the ground, or where fertilizers, particularly potash fertilizers, are added, abundant crops have been produced. In addition to the cereal growing at the Rampart Station, all of the leading vegetables are being experimented with.

At the Fairbanks Station the work is yet in a pioneer stage. The development of this station was begun in the spring of 1908, and during the past season 30 acres were in crops, mostly planted to oats for oat hay, although there were some experimental plats and about 3 acres in potatoes. In the experimental plats 2 varieties of winter wheat, 1 of winter rye, 12 of spring-sown oats, and 6 of barley matured. As indicated above, the principal area for cultivation was sown to oats for seed and for hay, and while both crops were light the grain was well matured where it was allowed to stand until the end of the season. A few of the very necessary buildings have been erected, and a portion of the reservation is fenced. Additional buildings and fences are needed, and also some additions to the equipment of implements and tools. It is intended to develop the Fairbanks Station on a considerable scale to demonstrate the practicability of farming in the Tanana Valley. After the pioneer work has been completed, it is expected that the cost of cultivation and receipts from the sales of crops will be accurately determined so that the data will be available for settlers in the future.

The animal-breeding work on the Kodiak Island has continued along the lines previously described. The portion of the herd which gives promise of being of value for dairy purposes is kept near the village of Kodiak, where a reservation of about 300 acres has been placed under fence. The other cattle of the beef type have been taken some 15 miles from Kodiak, to a tract of land on Calsinsky Bay, which has been fenced. Several head of cattle were lost from the herd at Calsinsky Bay in March, due to impaction of the third stomach, as a result of eating beach grass found along the beach after the snow had melted. As the cattle had been taken to this place late in the season, there was not enough forage on hand, and many of them fed upon this dry beach grass, with the result that their stomachs became impacted and in a number of instances death followed. Precautions have been taken against the recurrence of these conditions by fencing the tract and providing silage and hay in quantity that should be ample to carry the herd of 50 head through the winter. The summer conditions for the herd have been exceedingly favorable. There has been no sickness among the cattle during the past year, and the young stock have grown well, and all were in fine condition at the close of the pasture season. The experiments have thus far demonstrated the value of the Galloway breed for Alaskan conditions. These cattle have been fed in the last year exclusively on native grasses, either in pasture or with silage or hay made from them. A successful attempt was made in growing spurry at Kodiak, and a pasture of this plant was produced which was much relished by the cattle. It is probable that the winter feed of silage and hay made from native grasses could readily be sup-

plemented by oat hay and such root crops as turnips and ruta-bagas, if it were practicable to grow them at this time, but the resources of the station do not permit the necessary equipment of implements and labor for growing these crops.

The stations continue to cooperate quite extensively with farmers and others throughout the Territory, and successful reports have been received from a large number who have taken up agricultural pursuits as a result of the reports previously published by the stations.

HAWAII STATION.

The heads of the different departments of the Hawaii Station report considerable progress with their investigations and a gratifying appreciation of the efforts of the station.

The agronomist has continued to make rice and cotton investigations the main lines of work in his division. The cultural and fertilizer work with rice is giving results of great value, and some of the ordinary varieties of rice introduced by the station have been widely planted with gratifying results. The variety referred to in previous reports as No. 19 has been firmly established, and over 700 pounds of seed rice of this variety was distributed to growers in 1909. This variety is a pure strain developed from seed obtained through the Bureau of Plant Industry of this Department from Ceylon stock grown at Georgetown, British Guiana. As this rice has some very superior qualities and the difficulties attending its economical milling have been overcome, its wide cultivation is soon to be expected. The experiments with fertilizers are being continued at the station and also in cooperation with some of the largest rice growers to determine the effect of certain fertilizing elements and the most advantageous times for their application. The methods of fertilizing the rice crop described in previous reports have been put in application and have resulted in more than doubling the yield of ordinary rice lands. A study is being made in cooperation with the chemist on the constituents removed from the soil by the rice plant at different stages of its growth and the effect of the removal of the fertilizing elements on the physical character of the soil. Cooperative experiments with upland rice have shown that this crop can be depended upon for an excellent quality of grain hay, thus furnishing a much-needed local supply of forage.

An unusual interest has been manifested in the cotton experiments of the station. These were begun in the spring of 1908 and are being carried on with a considerable number of varieties representing Upland, Chinese, Egyptian, Sea-island, and Caravonica cottons. All these varieties have been found to grow as perennials, and experiments have shown that by pruning the fruiting season may be controlled and that through the removal of the old wood considerable

advantage in the control of insects is obtained. In the progress of these experiments efforts were made to obtain pure strains of the cotton, and it was found possible to grow cotton by cutting, budding, or grafting. This is of especial value for the rapid production of desirable strains and the elimination of the possibilities of cross-fertilization. The area planted to cotton in Hawaii during 1909 was about 100 acres, and as a result of the past year's work there will probably be several thousand acres planted in 1910. All of the commercial ventures thus far undertaken in planting cotton have proved very encouraging. The yield and quality of the lint have been remarkable, and it seems probable that a new industry for Hawaii is assured, which is adapted to regions where either by reason of elevation or lack of rainfall there is not sufficient moisture for cane growing.

The work with forage crops has assumed considerable importance, and these crops are being recognized in systems of rotation. The acreage of alfalfa, sorghum, Para grass, and other forage crops is increasing rapidly.

The work with the Chinese and Japanese matting rushes has been continued and a number of cooperative plantings made that show the economic possibilities of growing these plants. It is apparent that they can be readily produced in Hawaii, the only drawback being the problems relating to their manufacture.

The horticultural investigations have been largely confined to methods of propagating citrus fruits and mangoes, although other tropical fruits are receiving attention. The horticulturist has found that the mango can be successfully and rapidly propagated by means of budding. This is best secured by the application of the shield method of budding in the form of an inverted T, using only well-matured wood and cutting the T and the shield very long, the former 6 or 7 inches and the latter 3 or 4 inches in length. These quickly form a union, and the method is believed to be less troublesome and more rapid than inarching. In connection with the budding experiments it was found necessary to give attention to some of the insect pests, such as scale insects and aphids, and in cooperation with the entomologist, fumigating with hydrocyanic-acid gas was found satisfactory. The use of cover crops in orchards is being given attention, as during the winter season on the hillsides there is excessive washing of the soil. To prevent this erosion cowpeas and jack beans have given the best results. A series of experiments with a number of vegetables is in progress and considerable work is being done to secure better and more resistant varieties of horticultural crops.

The chemical department has given most attention to a study of pineapple soils, although in cooperation with the agronomist some experiments on the fertilization of rice and cotton are being carried

on. In studying the pineapple soils, particularly those on the island of Oahu, where pineapple planting is being rapidly extended, two types of soil were recognized, red and black. In general the former seems better adapted to the crop. A study of the black soils showed in some instances as much as 10 per cent manganese. This is quite soluble and when absorbed by the plants causes them to turn yellow. In the red soils a large amount of ferric hydrate is present and this causes the soils to have a high water-holding power. During periods of heavy rainfall the red soils become saturated with water, resulting in imperfect aeration. Means are being investigated to overcome the injurious effect of manganese in the black soils and to provide against the water-logged condition of the red soils, so that the cultivation of pineapples will be placed on a more secure basis.

The entomological work has consisted quite largely of a study of the cotton and pineapple insects and working out methods for their control. Leaf-eating caterpillars were particularly injurious during the year and it was necessary to devote some attention to these pests. Cutworms and army worms attacked a variety of crops, including rice and alfalfa, causing a good deal of damage, but fairly satisfactory methods of controlling these pests have been applied. The army worm appeared in the rice fields in one of the districts of Oahu, causing the destruction of nearly half the crop. This is believed to be without precedent in the history of the rice industry in Hawaii. A systematic study has been begun on the plant lice of the islands, and a number of new species have been found and many important facts regarding their life histories have been worked out. Arrangements have been made for cooperation with the Bureau of Entomology of this Department in the introduction of parasites of the algaroba bean weevil, plant lice, etc.

A number of miscellaneous investigations were carried on by different members of the station staff, among them tapping experiments, in which about 500 rubber trees were experimented with to determine the best method of tapping, the possibility of economically using Japanese labor, the time of day at which tapping should be made, the effect of tapping upon rubber trees, methods of coagulating latex, and the stimulating effect of fertilizers upon the flow of latex. It was demonstrated that trees could be tapped any time from 5 a. m. until noon, and a sufficient flow of latex was secured to indicate that the Ceara rubber tree may be planted in Hawaii on a commercial scale with reasonable assurance of profit. Vertical cuts were found to give better results on Ceara trees than any other form of tapping tried. Samples of rubber collected by the station were submitted to experts and were valued at \$1 to \$1.30 per pound, a price almost equaling that of Para rubber at the same date.

Some attention has been given to methods of grinding algaroba pods in order that the hard seeds should be crushed and their protein not lost in feeding. Through the cooperation of a skilled mechanic a machine has been devised that grinds these pods, and it is probable that its use will greatly add to the available nutritive value of the algaroba beans, which are used as stock feed in large amount.

On account of the presence of perennial weeds, various means for their control have been investigated, and the use of carbon bisulphid was found to successfully destroy herbaceous and shrubby weeds. The application of a small portion of the chemical to the stems results in the death of the plant within a period varying from a few hours to several weeks.

In addition to these investigations, the station has in progress rotation and cultural experiments with a large number of tropical crops.

PORTO RICO STATION.

The experiment station in Porto Rico has made substantial progress with its work and investigations during the past year. While the opportunity for work at a tropical experiment station is very great, nearly every line of agriculture requiring investigation, the Porto Rico Station has very properly concentrated its efforts on a few definite lines. The agricultural conditions of Porto Rico are improving, and as more modern methods are being adopted the planters of the island are calling upon the station for more and more assistance. These are responded to as far as possible, and the station seeks by every means to bring the results of its investigations before the people. When the proposed agricultural college is established and equipped much of this work will be turned over to the new institution, relieving the station of a great deal of the elementary and demonstration work and permitting more time to be devoted to investigations. Considerable cooperative work is being carried on with various planters in testing new varieties of economic plants, fertilizer tests with various crops and soils, shipping experiments with tropical fruits, and similar work. Some of the leading results of the past year's work are presented below.

The physiologist has made an especial study of the so-called tired or sick soils. These soils while apparently fertile, so far as chemical analysis will show, do not produce profitable crops. Studies were made of a considerable number of coffee, pineapple, and cane soils, and in all cases where there was trouble the soils were found to contain a great excess of butyric acid. Associated with this acid were a number of bacteria, which develop rapidly in soils when roots or other organic matter containing sugar and starch are present. Through the fermentative activity of these organisms butyric acid

is formed. In general no essential difference appears between healthy and sick soils in regard to the number of aerobic bacteria, but a difference is found in the number of anaerobic organisms present. The investigations thus far carried on have shown that the butyric acid is a product of several kinds of bacteria, the varieties thus far observed in Porto Rico appearing to be facultatively anaerobic. Disinfecting experiments have shown the possibility of correcting the injurious properties of the soil through the destruction of the bacteria, and the application of lime and gypsum to such soils has proved beneficial in some instances.

The orchards of citrus fruits are coming into bearing, and it will soon be possible to report definitely upon the value of certain varieties for Porto Rican conditions. Out of 50 varieties of oranges 30 fruited this year, of 16 varieties of grapefruit 6 fruited, and 8 varieties out of 13 of lemons bore fruit this year. The varieties on the station grounds represent all the leading commercial forms, as far as they could be obtained, as well as a number that are less known and a few promising local seedlings that appear of value. Experiments are being carried on to determine the best kind of stock for citrus trees in the different types of soils of Porto Rico. The fertilizer experiments with citrus trees have been in progress for four years, and it is hoped that with one more year's work it will be possible to formulate some definite conclusions regarding their use. Plantings of mangoes, avocados, and other tropical fruits have been made and attempts are being put forth to propagate the best varieties as rapidly as possible. Some important data regarding the inarching of mangoes have been secured and the horticulturist has been able to produce inarched trees ready for setting in the orchard within three months of the time when the seed for the stock was planted in pots. The attempts being made to reforest the bare hills and wet grounds of the station are progressing favorably. Various species of Eucalyptus have been introduced and appear promising for future planting. Considerable time and attention is being paid to the introduction of desirable horticultural species, many varieties being received through the cooperation of the Bureau of Plant Industry of this Department. A tract of land has been set aside for the reception of these plants, and the introduction work will be made a definite feature of the horticultural investigations.

The entomologist has devoted considerable time to studies of the insects affecting citrus trees, and has prepared a bulletin regarding these pests, with suggested means for their control. It has been found practicable to fumigate orange and grape-fruit trees in Porto Rico as a means of controlling the scale insects. Some work is also in progress with fungi that are parasitic on scale and other insects. The value of sulphur sprays and oil emulsions has been tested, and

they have been found very efficient for the control of the rust mite, purple scale, and other pests. Some modifications had to be worked out in the prescribed formulas to adapt them to Porto Rican conditions. Experiments have been taken up in cooperation with several planters for the control of the larvæ of one of the Lachnosterna beetles. These larvæ are very destructive to the roots of sugar cane, and it was found that lime applied about the stools of cane seemed to reduce the number of grubs, the female beetles apparently being repelled by the conditions where lime was applied. The life history of this insect as it occurs in Porto Rico is being studied. The entomologist carried on some experiments on the fumigation of tobacco in the warehouse to prevent injury by beetles, and has devised a method of fumigation with potassium cyanid by which large amounts of tobacco can be treated. Breeding work with *Telenomus monili-cornis*, the parasite of the eggs of the tobacco hornworm, has been continued, and large numbers of the parasites were distributed not only in Porto Rico, but were sent to the Bureau of Entomology of this Department for distribution. Other miscellaneous entomological experiments are in progress.

Much of the time of the chemist was taken up in the installation of the laboratory and in miscellaneous analytical work on guanos and other fertilizers, soils, waters, and other material. The principal investigations of this department have been on soil disinfection and plant nutrition. The injection of carbon bisulphid was found very efficient for the control of abnormal soil conditions which result in the so-called sick soils, but the cost of the treatment proved prohibitive. Experiments are in progress with some of the cheaper germicides to see whether they will not prove equally valuable in correcting the soil conditions. A study was begun of pineapple soils to determine the cause of failure on the part of plants when set in certain types of soil. This is closely connected with the studies in plant nutrition in which an excess of lime was found to result in a chlorotic condition of the plants. To overcome some of these troubles the lime and magnesium ratio for various crops and soils is being studied.

The experiments at the coffee substation are progressing. Some of the varieties of coffee introduced from Java, Arabia, and elsewhere have come into bearing and their characteristic qualities are found unimpaired when grown under Porto Rican conditions. All the seed produced by these plants have been distributed, and the requests for seeds of the better varieties far exceeded the supply. In several instances the coffee expert has aided planters in the construction and planting of seed beds. Experiments with windbreaks about and through coffee plantations have demonstrated their value, and trials have been begun of two native species of plants for this purpose.

The experiments with the old and new plantings of coffee have been continued, and in the old plantation the cost of production last year was \$5.18 per 100 pounds of coffee, which was sold for \$11.98. In the new plantation the cost for the five years since this experiment was begun has been \$101.56 per acre. A small crop was gathered last year, the net value of which was \$8.85, making the net cost of planting, culture, and other factors, for the first five years, \$92.71 per acre.

The plant pathologist is continuing his investigations along the lines described in the previous report. The diseases of citrus fruits have received but little attention, no new problems having appeared. A disease of mangoes similar to the wither tip is receiving attention. Spraying with Bordeaux mixture was found to give good results at the station, the sprayed trees bearing heavily while the unsprayed ones yielded little or no fruit. Some studies on the diseases of pine-apples and cacao are in progress and various treatments are being tested. The coffee trees have been found subject to a number of fungus diseases. The leaf blight (*Pellicularia koleroğa*) was quite destructive during the wet season. A second leaf blight (*Stilbum flavidum*) is of comparatively little importance, as the conditions for its best development are present only at elevations of 2,000 feet or more and relatively little coffee is produced in Porto Rico at this elevation. A new disease of coffee in which the tree trunks are girdled at or near the ground is being investigated. Some attention is being given to the diseases of sugar cane and their control, and the methods recommended as effective in other countries are being tested. Some progress is reported on studies of the fungus parasites of aphids and scale insects.

The station has added to the equipment of live stock and has a number of head of horses, cattle, hogs, sheep, and poultry, all of which are being used in breeding experiments. These experiments have been in progress long enough to warrant some possible conclusions. With cattle the prepotency of Shorthorn and Hereford sires is very apparent. Four young crossbred Indian bulls of the race Hissar were obtained during the past year. They were secured to renew the vigor of an introduction made some sixty years ago, the presence of which blood is still apparent in the size and conformation of many of the work animals. The Berkshire breed of hogs has proved well adapted to Porto Rico, and 21 head were sold at a nominal price for breeding purposes. The experiments with African woolless sheep have proved successful, the flock being increased during the year from 6 to 20 head. Great interest is taken in the poultry work, and during the year the station sold 14 cockerels and pullets and 142 settings of eggs. The nonsitting breeds seem most suited to Porto Rican conditions, although the intermediate ones,

like Plymouth Rocks and Wyandottes, seem to do very well. On account of the scarcity of the usual feeds for stock, experiments are being conducted on the cost and efficiency of a large range of materials. It has been demonstrated that silage can readily be produced from malojilla grass, cane tops, and corn. The study of concentrates is being continued and will be reported upon as the work proceeds.

GUAM STATION.

Following the appropriation by Congress of \$5,000 for the establishment and maintenance of an agricultural experiment station on the island of Guam, negotiations were begun to secure a suitable site for the station. As stated in the previous report, no accessible public land of the character desired was available, and it became necessary to secure a tract from some private owner. It was considered inadvisable to purchase the tract originally selected, as the price asked was believed to be exorbitant, and another tract near by was selected. This belonged to Juan Torres, a resident of the island, and in December, 1908, it was leased with the privilege of purchase. This area consists of about 27 acres, located along the road from Piti to Agaña, and is so situated that it can be irrigated from the Maso River without great expense. This stream forms the western boundary of the land. The main portion of the tract is flat, of good character of soil, and it extends into the low hills on the south, where opportunity will be offered for experiments in such cultures as are adapted to the lighter hill soils.

Work was begun at once in clearing and fencing the land, and preparations were made for some experimental investigations. The fencing material was shipped from San Francisco, and in erecting the fence an experiment was undertaken in which temporary posts were planted, and alternating with them young silk cotton trees were placed for permanent posts. The clearing of the land proved a difficult matter on account of the dense tropical growth and the character of the plants found in the situation chosen for the station. A considerable portion of the tract was cleared and fenced, and with the first rains seeding was begun.

A period of unusual drought was experienced in Guam early in 1909, and as a result it was impossible to make much headway with the planting. A number of investigations with forage and other plants have been begun with seeds sent from this Department, as well as some furnished through the Hawaii Experiment Station. The investigations during the past year were largely confined to the growing of Guinea grass, Bermuda grass, and three varieties of sorghum. In addition the growing of leguminous plants between the rows of forage crops is being tried. The forage plants thus far tested have proved very satisfactory in spite of the prolonged

drought, and as soon as other areas are available the forage-crop plantings will be extended. The recent drought has emphasized the necessity for the introduction of forage plants, as cattle and other stock were forced for several weeks to live on the leaves and twigs of trees. The drought also called attention to the urgent necessity of extending agricultural production, as special importations of rice and other foodstuffs were required to relieve the suffering of the people.

Immediately following the decision relating to the establishment of the station in Guam, a considerable number of economic plants were sent from Hawaii, and these have been planted and are reported as growing vigorously. Among these are varieties of pineapples and avocados, the pineapples being of much better quality than those already growing in Guam. The first avocados on the island were a few trees that were sent to the governor of Guam some five years ago. These flowered this year and the fruit produced is said to have been of a very excellent character. The introduction of this fruit and the improved varieties of pineapples will undoubtedly be of great benefit to the people of Guam.

An experiment was begun to test the possibility of converting some of the savanna lands into arable tracts. These lands are quite extensive and at present are covered with a coarse grass that has no value except when very young. At that time it is eaten to some extent by stock but does not seem to be greatly relished. The experiment consisted of planting leguminous trees (*Leucana glauca*), with the hope that they will either increase the fertility of the soil through the well-known power of leguminous plants to collect nitrogen or that through the shade produced by the trees it will be possible to protect seedlings of more valuable species. If this experiment should succeed, it will be possible to considerably extend the area under cultivation or at least the wooded area of the island.

Experiments have been begun with several varieties of American field corn, comparing them with the variety commonly grown upon the island. One of the most serious drawbacks to agriculture in Guam is the difficulty of storing seeds. In the case of corn and similar plants weevils are very abundant, and some experiments are contemplated on the storage of grain.

The coconut disease that threatened to be so destructive to the leading industry of Guam is being given attention. It is found that this trouble is due to mealy bugs, and there have been introduced from Hawaii a number of ladybirds, which, it is hoped, will materially aid in combating this disease. Some experiments have been begun in the planting of coconut trees with the hope that means will be found to hasten their development, so that the trees will begin bearing several years earlier than is the case under the usual methods

pursued in Guam. As opportunity offers some attention is being paid to the fungus diseases and insect pests of other crops on the island. A number of these are known, and some experiments have been begun for their control.

At the end of the fiscal year Mr. J. B. Thompson, a graduate of the Kansas Agricultural College, who had had several years' experience with the Bureau of Agriculture in the Philippine Islands, was placed in charge of the station, with Mr. H. L. V. Costenoble as assistant. This arrangement will not in any way change the policy of the station, but will bring it more under the influence of American experiment stations.

At present the station has a site partially cleared and completely fenced, and a number of the more urgent buildings are erected. These will have to be supplemented by other buildings in the near future, as the station is situated at a distance of several miles from Agaña, the principal town of the island, and a house for the superintendent will be required. Some provision should be made for the erection of stables, implement shelters, and similar buildings, all of which can be provided from the resources of the island at no very great expense.

A number of carabao have been purchased as work animals, and as soon as a permanent source of forage is provided, so that it will not be necessary to ship hay and grain from San Francisco, an effort will be made to introduce some better classes of live stock. Under the conditions now existing in Guam the introduction of live stock is not considered advisable, as those now at the naval station are fed almost exclusively on hay and grain shipped from San Francisco or Seattle.

The work of this station for some time will consist principally of demonstrations in methods of agriculture and the introduction and testing of field and horticultural crops. Already the people are beginning to exhibit an interest in the work, and requests for advice have been received in considerable numbers. In a limited way cooperative experiments have been undertaken with farmers, and the station has distributed field and garden seeds. These have been gladly accepted for trial plantings by quite a number of actual farmers. It is hoped that some arrangement can be effected whereby regular supplies of seeds can be obtained, as the vitality of all kinds of seeds, unless especially protected, diminishes rapidly in the moist tropical climate of Guam. A considerable number of improved agricultural implements have been introduced, and as they are found adapted their use by the farmers of the island will be recommended. It is quite probable that some modification of the types usually supplied by implement dealers in the States will be required to make them adapted to the conditions in this island.

NUTRITION INVESTIGATIONS.

The object and aim of the nutrition investigations as a whole is to collect and spread information regarding the value as food of agricultural products, both animal and vegetable, in such a way that the producer, distributor, and consumer may be benefited.

For experimental work in this subject special apparatus and methods are required and these have been developed as the enterprise has progressed. Of particular importance is the respiration calorimeter, an instrument of precision for use in experiments with men. It is possible with the aid of this apparatus to study with an accuracy not otherwise attainable the effects of various foods and other factors, as shown by changes in the income and outgo of matter and energy in the body.

The respiration calorimeter, which was brought to Washington from Middletown, Conn., where it had originally been built, has been reconstructed in quarters assigned to nutrition investigations on the ground floor of the east wing of the new Department of Agriculture building. It was not found necessary or desirable to modify the general lines on which the calorimeter was originally built, but in the reconstruction many improvements in details were introduced which make for simplicity, economy, and convenience of operation and for accuracy in the results obtained. The accessory laboratory appliances and equipment necessary for use in connection with the respiration calorimeter experiments have also been installed, and the equipment as a whole is being used in studies of the nutritive value of agricultural products along lines in harmony with the general work of the department.

As a whole the enterprise involves cooperation with other bureaus and the supplementing, and not the duplication, of their work where it concerns the utilization as food for man of dairy products, cereal products, and other foodstuffs.

Most families use cheese to a greater or less extent, but in the United States it is the custom to use it in rather small quantities and more as a condiment than as a staple article of diet, perhaps owing to a belief that cheese in quantity disturbs digestion. This question has for some time constituted an important feature of the nutrition investigations, and it has been found that cheese is thoroughly digested when eaten in quantity as a chief source of protein and fat in the diet and that it does not produce physiological disturbances. To round out this work information is needed regarding the ease of digestion of cheese as compared with other staple foods, and this question is being studied with the respiration calorimeter. As was the case in earlier work, cheese made and cured in different ways will be used and the different varieties will be compared with each other and with meat, bread, and other standard food products.

It is also proposed to study the relative value as sources of energy in the body of butter, lard, beef fat, olive oil, and other edible or culinary fats, a matter on which data are much needed in considering problems of special interest to the Department of Agriculture at the present time.

Studies already made and in part reported have shown the value as an integral part of the diet of fruits and of preserves, jams, jellies, dried and evaporated fruits, etc., and of nuts and nut products, a matter which is of importance to all who are interested in growing fruits and nuts and the manufacture of food products from them. The additional studies of such materials which are needed involve the use of the respiration calorimeter for the measurement of factors which have not as yet been determined.

It should also be said that no other means of experimenting offers so much hope of ultimate success as the respiration calorimeter in the study of the relative energy expenditure required of the body for performing different kinds of farm and household work and in studies of the relation of physical work of this and other sorts to food supply, a question of special value at a time when high cost of living makes reasonable economy desirable in a large number of families.

Investigations of the food value of meat of different kinds and cuts prepared for the table in a variety of ways have been carried on for several years as a part of the nutrition investigations. As the result of this work, and some special tests which have been undertaken, a summary of data has been prepared for publication regarding the use in the home of the cheaper cuts of meat in palatable ways, a question which is of much importance in economical household management.

The question of supplying food under municipal or philanthropic auspices to needy school children is one which is assuming great importance, and data regarding many phases of this question are frequently requested from the Department of Agriculture and can be supplied from the accumulated results of past experiments. However, some additional information should be sought by the improved methods of experimenting now available.

Many requests are also made by institution managers for advice and suggestions regarding food problems presented by the feeding of a large number of persons under more or less uniform conditions. In this case also it is possible to supply a large amount of information on the basis of facts accumulated from past experiments, though additional data are needed.

The work of the Department in nutrition investigations and kindred lines has a vital relation to the work of the agricultural colleges. In response to a widespread demand among farmers and other people, these colleges are conducting courses in home economics in which

instruction regarding the nutritive value of different foods and ways of handling and cooking them is an important feature. These colleges have for years looked to the Department for aid in this line and are now doing so more than ever. The agricultural colleges have been stimulated by a recent act of Congress to organize courses for teachers along this line, as well as other branches of agricultural and mechanical arts. Secondary and primary schools all over the country are taking up this work, and the demand for teachers and for information outruns the supply.

Recognizing the importance of the nutrition investigations of the Department in this connection, students, teachers, investigators, and individuals interested in the problems are turning to the Department in increasing numbers for information and suggestions. This is one phase of the great movement for the improvement of life in both country and city through education directly relating to home interests and the vocations of the people and the dissemination of information along such lines. It has long been understood that work of this character has been undertaken by the Department, and the demand for information continues to increase.

In accordance with the usual policy of the Department, the results of the nutrition investigations have been published as technical bulletins in limited editions, while the general deductions of popular interest which have been drawn from the investigations have been summarized in Farmers' Bulletins and other popular publications designed for general circulation.

Up to the present time 59 technical bulletins and 43 Farmers' Bulletins and other popular summaries have been published as a result of the nutrition investigations, as well as numerous reports of progress and similar articles. The nutrition publications issued during the past year have included three technical bulletins, one Farmers' Bulletin, and one circular. The subjects treated in these publications are as follows: The influence of muscular and mental work on metabolism and the efficiency of the human body as a machine; dietary studies in rural regions in Vermont, Tennessee, and Georgia; and dietary studies in public institutions in Philadelphia and Baltimore; all three of these publications being technical bulletins. The Farmers' Bulletins have to do with the use of milk as food and the care of food in the home. The circular briefly describes the organization of the nutrition investigations and lists and describes the publications issued in connection with the enterprise.

In addition to the above, a new Farmers' Bulletin has been prepared for publication, and one of the earlier issues has been rewritten and brought up to date, while three special articles have also been prepared for publication and two technical bulletins are approaching completion.

As a part of the regular work in nutrition, abstracts of the current literature on the general subjects of physiological chemistry and nutrition have been prepared for the Experiment Station Record, as well as popular summaries, particularly of work carried on at the American experiment stations, for publication in the series of Farmers' Bulletins entitled "Experiment Station Work."

As has been the case for many years, many requests for information along nutrition lines have been received from Members of Congress, teachers, institution managers, home makers, and others. The work connected with nutrition investigations, as heretofore, has been in charge of Dr. C. F. Langworthy.

IRRIGATION INVESTIGATIONS.

The irrigation investigations of this Office continued during the year 1909 along the same general lines as before, under the direction of Samuel Fortier as chief.

The great activity in the extension of irrigation works, noted in previous reports, has continued in full force, if it has not increased. During the last two years this Office has been preparing and publishing a series of reports on irrigation in the several arid States and Territories, these reports being prepared by the state and territorial engineers where there are such officials, and by other local men where there are no engineers. Most of these reports contain statements of the areas under ditch, but not irrigated, although some do not. The following table, showing the areas under ditch, but not irrigated, is compiled from those reports and from correspondence with well-informed persons in the several States. The names of all the arid States and Territories are included in the table in order to call attention to the area not covered by the total.

Areas under ditch, but not irrigated, 1908.

	Acres.
Arizona -----	
California -----	1, 375, 000
Colorado -----	880, 000
Idaho -----	1, 336, 600
Kansas -----	50, 000
Montana -----	
Nebraska -----	500, 000
Nevada -----	
New Mexico -----	100, 000
North Dakota -----	
Oklahoma -----	
Oregon -----	380, 000
South Dakota -----	
Texas -----	861, 000
Utah -----	100, 000
Washington -----	200, 000
Wyoming -----	
Total -----	5, 682, 600

The table gives areas for 10 States and none is given for 7 States, but the 10 States for which areas are given contain much more unirrigated lands under ditch than the others. However, Arizona, Montana, Nevada, and Wyoming contain large areas of such land, the report on irrigation in Wyoming containing an estimate of 800,000 acres now in process of reclamation, while the Dakotas and Oklahoma do not contain large areas under ditch. We have not sufficient basis for an estimate of the area in the States for which no figures are given, and it is quite probable that the estimates for the other States include land under existing ditches which do not supply enough water for all the lands under them, but the areas in the States not reported will considerably more than offset the excess areas in the other States, so that the figures seem to justify an estimate of a total area now under ditch and awaiting settlement somewhat in excess of 6,000,000 acres.

Some of the reports cited above contain estimates of the areas under projects now in course of construction, without stating how much is now irrigated. The table which follows is compiled from these statements and from the reports of the Secretary of the Interior. The areas given under the States are exclusive of the United States Reclamation Service and Carey Act projects:

Areas in the process of reclamation.

United States Reclamation Service:	Acres.	Acres.
Total area now under projects.....	3, 037, 961	
Area now irrigated.....	424, 549	
Area being reclaimed.....		2, 613, 412
Carey Act:		
Area segregated.....	2, 766, 600	
Area patented	314, 564	
		2, 452, 036
Arizona		
California		400, 000
Colorado		400, 000
Idaho		50, 000
Kansas		50, 000
Montana		
Nebraska.....		85, 000
Nevada		
New Mexico.....		150, 000
North Dakota.....		
Oklahoma		
Oregon.....		80, 000
South Dakota.....		
Texas.....		900, 000
Utah.....		
Washington		134, 000
Wyoming.....		375, 000
Total.....		8, 689, 448

There is undoubtedly some duplication in the two tables given above, so that the sum of the two totals could not be taken as the area which will be available for settlement within the next few years. On the other hand, many large projects which are in a more or less complete state of organization are not included in the tables. However, the tables seem to justify the statement that there is now available for settlement an area of 6,000,000 acres, with as much more under ditches now under construction, which will be available within a few years. This Office has estimated the area now irrigated at 13,000,000 acres, and therefore the works now under construction will provide for the approximate doubling of the area.

This large increase in the area irrigated will be made at a great increase in cost per acre irrigated. The United States Census reports give the average cost of irrigation works in the United States up to 1900 as \$8.85 per acre irrigated, and up to 1902 at \$9.14 per acre irrigated.^a Data for an average up to the present time are not available, but the reports of the Secretary of the Interior show that the average cost of the works built under the Reclamation Law has been as follows:

Estimated average cost of irrigation works as shown by statements of areas to be reclaimed and estimated cost of works, published in annual reports of the Secretary of the Interior, 1904 to 1908, and table supplied by the United States Reclamation Service, 1909.

Year.	Total area.	Total cost.	Average cost per acre.	Year.	Total area.	Total cost.	Average cost per acre.
	<i>Acres.</i>				<i>Acres.</i>		
1904.....	1,332,000	\$26,970,429	\$20.25	1907.....	1,910,000	\$70,000,000	\$36.65
1905.....	1,028,600	27,930,000	27.15	1908.....	2,292,346	\$9,431,500	39.00
1906.....	1,263,600	39,155,161	31.00				

The averages given above are based on total acreages and total cost. The cost under the different projects varies from \$25 to \$65 per acre. That the cost of other works is not far different from that of the government works is shown by the data on irrigation contained in the Statistical Abstract of the United States for 1908 (Department of Commerce and Labor). As stated there, the cost of irrigation works in the United States in 1902 was \$77,430,212, and the area irrigated 8,471,641 acres; the cost in 1907 was \$125,000,000, and the area 9,700,000 acres. The increase in the area from 1902 to 1907 was 1,228,459 acres, while the increased cost was \$47,569,788, or an average of \$38.72 per acre. The table for the government works includes the year 1908, while the other does not, which would account for the slight difference between the average cost found in the two ways.

^a U. S. Dept. Com. and Labor, Bur. Census Bul. 16, p. 11.

The high cost is further shown by the following table, showing the cost of water rights under Carey Act projects in Idaho:

Table of Idaho Carey-Act projects, with cost per acre and date of opening.

Name of company.	Date of opening.	Cost per acre.
Marysville Canal Company.....	1898	\$6-20
American Falls Canal and Power Company.....	1900	15-25
Canyon Canal Company.....	1901	25
Twin Falls Land and Water Company.....	1901	25
Twin Falls North Side Land and Water Company.....	1907	30
Pratt Irrigation Company.....	1907	28
Portneuf Marsh Valley Irrigation Company.....	1907	35
Twin Falls North Side Land and Water Company (second segregation).....	1908	35
Huston Ditch Company.....	1908	25-35
Idaho Irrigation Company.....	1908	35
Twin Falls Salmon River Irrigation Company.....	1908	40
Twin Falls Clover Creek Irrigation Company.....	1908	45
Big Lost River Irrigation Company.....	1909	40
West End Twin Falls Irrigation Company.....	1909	40
Idaho Irrigation Company (second segregation).....	1909	50
King Hill Irrigation and Power Company.....	1909	65
Twin Falls Oakley Irrigation Company.....	1909	65
Idagon Irrigation Company.....	1910	60
Twin Falls Land and Water Company Extension.....	1910	65
Owyhee Irrigation Company.....	1910	65
Southern Idaho Reclamation Company.....	1910	70

Assuming then that the cost of the reclamation works represents an average for all the works now under construction, there is an increase of 327 per cent over the average cost of works built prior to 1902.

The great increase in the area under ditch and the enormously increased cost at which the land is being brought under ditch are the dominant factors of the irrigation situation at the present time. The high cost limits settlement to persons with considerable capital, and at the same time limits the crops which may be grown to those giving large returns per acre. During the first few years after works are built maintenance charges are large, and if the lands are not settled at once these must be added to the purchase price, making the situation more and more acute. The situation is this: A large area of land under expensive works, requiring immediate settlement by persons with considerable capital who must at once bring the land into a high state of productiveness. To offset this, there is undoubtedly an unusually strong desire on the part of a great many people to go from the cities onto the land, to leave the life of the factory, the store, and the office for that of the independent producer. The intensive cultivation of a small area, with an assured water supply and a large and assured return appeals to them. Great numbers of such people are buying the high-priced irrigated lands. They are a high class of citizens and, as a rule, they have some little capital, but generally they are ignorant of agriculture in any form, and almost universally they are totally ignorant of irrigation. They are abandoning the occupations of a lifetime for a new one of which they know nothing,

in which the expenses are so large that a few mistakes mean failure for the settlers, and the failure of the settlers means the failure of the enterprises.

The Office has realized fully the gravity of the situation and therefore has devoted the greater part of its attention for the last few years to collecting information as to the best methods of performing all the agricultural operations peculiar to farming under irrigation, and placing this information within the reach of the new settlers in the arid region. This has been done by publishing in popular form bulletins on the preparation of land for irrigation, the building of ditches and ditch structures, and applying water to the principal crops of the irrigated farms; by lectures; by personal advice whenever possible; and by cooperating with the state experiment stations and with private parties in the maintenance and operation of experimental and demonstration farms. Such farms have been maintained during the past year in California, Oregon, Washington, Idaho, Nevada, Colorado, Wyoming, and North Dakota.

While the leading feature of the work has been the aiding of settlers in the newer regions, none of the other lines of work carried on in the past has been abandoned.

Tank experiments to determine the quantities of water lost by evaporation under different methods of applying water to crops and different systems of cultivation were continued, and tanks put in at several additional points.

The work of demonstrating the advantages of irrigation in sections where crops can be grown without it has been continued and extended. In the Willamette Valley, Oregon, which has a very heavy annual rainfall, the practicability of irrigating through the summer drought has been thoroughly demonstrated and the practice of irrigation is being extended rapidly in that valley.

At Cheyenne and Newcastle, Wyo., and Eads, Colo., in the so-called "dry-farming" region, the last few years have been seasons of much more than normal precipitation, yet the farms maintained at those points have demonstrated beyond doubt the practicability of irrigating small areas with pumped water. In years of unfavorable precipitation the value of the small irrigated areas will stand out much more clearly.

While the semiarid region has been enjoying an abnormally heavy precipitation the Atlantic States have been suffering from annual droughts which have created a great interest in irrigation, this interest extending from the Lakes and the St. Lawrence to the Gulf of Mexico. From this section there has been a strong demand for advice as to methods of using water, and for the last two seasons an expert has devoted his entire time to this section, giving advice to farmers and conducting demonstrations in cooperation with farm-

ers at points scattered throughout the whole humid section of the country. Here, as in the newer sections of the West, the present demand is for practical directions for performing the agricultural operations connected with irrigation.

In both the humid and arid sections, as irrigation becomes more generally practiced, there will be more demand for the study of the scientific questions connected with securing the largest use of the available water supply and the best development of the crops grown. Such work is now being carried on in the sections where irrigation has been practiced for a long time and the available water supply has been put to use, making extension of the irrigated area dependent upon stopping waste and more economical use. This work includes the measurement of losses of water from canals in conveying it to the place of use and the means of checking them, including the use of canal linings of various kinds; the cleaning of canals; the use of flumes and pipes for distributing water; adaptation of methods of applying water to the character of the water supply and of the soil and subsoil in order to attain and keep up the best moisture conditions in the soil; the effect upon the crop of applying water in different volumes and at different stages of the crops' development; and the effect of laws and regulations upon the use of water.

The rice districts of the South have irrigation problems peculiar to themselves, which are being studied. These include pumping, construction of field levees, depths at which water should be maintained on fields, systems of controlling the distribution of water.

Investigations of pumping are carried on throughout the United States, and an expert in that line devotes his time to giving advice on the installation and operation of pumping plants and the preparation of bulletins on the subject. The construction of reservoirs for the impounding of storm and flood waters is also being studied.

The authority for the irrigation investigations carried on by this Office is broad in its terms, and the purpose always in mind is to render the greatest service possible with the available funds. At present the greatest opportunity is in the section being brought under irrigation. As time passes this work will become less important, and the more scientific work will be expanded.

DRAINAGE INVESTIGATIONS.

The drainage of agricultural lands involves the consideration of such a number and variety of factors that to design drainage systems properly requires a knowledge of land and soil conditions obtained only by careful observation and no little experience. Every farmer who has desired to improve lands too wet for easy cultivation, as well as every engineer who is called upon to plan the reclamation of swamp lands or those periodically inundated by overflow from

streams, has experienced the need of definite knowledge upon this subject.

Drainage investigations of this Office undertake to collect the available information relating to agricultural drainage; to study the practice of this and other countries, learning the causes of success and of failure; to investigate the conditions affecting the design of drainage systems; and to use the information gained in this manner for encouraging the reclamation and improvement of wet lands. The Office also disseminates information regarding the methods and benefits of drainage, and assists landowners in devising plans for draining certain areas in order to test the value of such undertakings. The need for such studies is emphasized by the increasing number of inquiries received from every part of the United States and even from other countries. Information is asked regarding the proper depth and arrangement of underdrains and open ditches, the efficiency of drains in certain described soils, the effect of drainage upon the soil and upon crop production, and the methods and costs of construction. Other inquiries relate to the computation of flow in natural water courses and in artificial channels, the coefficients to be used in the hydraulic formulæ, and the effect of bends, obstructions, and non-uniform cross sections; also to the maintenance of ditches, the prevention of silting and of erosion. There is much need of reliable data concerning the amount of water that should be removed from drainage areas, how this depth is related to rainfall and size of area, and how it is affected by climate, soil, and topography. Many requests are made for personal examinations and for surveys, with definite plans for the work that may be found practicable. Assistance is desired in the organization of drainage districts where the cooperation of many landowners is necessary, in assessing the costs against property benefited, and in appraising damages, as well as in drafting general drainage laws.

Much information is given by correspondence, in reply to specific inquiries. Sketches and maps are received, with descriptions of soil and topography, from which drainage plans are outlined more or less definitely by the Office engineers. Frequently from personal inspection of the lands the engineers are able to recommend the plans to be followed and to make approximate estimates of the cost. Where necessary, drainage surveys are made by field parties, and the best plans of improvement worked out in detail. Plans prepared by local engineers are frequently submitted for the criticism or approval of the Office. The exceptional experience of the department engineers enables them many times to suggest changes that will make the work planned more effective or more economical.

The collection of data upon matters related to drainage is considered very important. A study is made of current drainage practice

in the United States and abroad. Special examinations are made of the soils that are most difficult to reclaim, such as peat and turf lands, tidal marshes, and the heavy alluvial soils, and of the effect of drainage upon the texture of soil. Investigations are made to determine the value of cement drain tile. Various types of excavating machinery are observed, and their fitness for the different kinds of drainage construction noted. Pumping plants are examined, and tests of their efficiency under different conditions have been made.

A large part of the work of drainage investigations is making surveys and preparing plans for draining lands permanently wet or periodically inundated. These surveys are undertaken in response to requests received from individuals and from organizations for assistance in initiating or perfecting drainage improvements. A preliminary investigation is first made by one of the drainage engineers, who ascertains approximately the extent and nature of the survey, the manner of conducting the field work, the probable benefit to property from drainage, as well as the interest shown by those who propose to carry out the project. When it is expedient for the Office to lend further assistance, a surveying party is organized. This party obtains accurate information regarding the existing water-courses, the area to be benefited, the slope and elevations of the ground surface, the proper location of new channels and levees, with any special data that may be helpful in designing the most practicable method of improvement. A report and maps are then prepared, setting forth the conditions existing, showing the proposed plan of drainage, and giving an estimate of the cost of construction. To determine the proper plan for a district, the field data should be collected with care, and good judgment must be exercised in the use of all information bearing upon the project. It is necessary to study carefully the amount and distribution of rainfall, the readiness with which water percolates through the soil, and the most practical methods of excavating ditches and building levees. All the details are fully considered and so explained that the plans can be followed with confidence. The report and maps, with such profiles and other drawings as are required, are transmitted to the local parties interested. Owing to the increasing interest in land drainage, the number of requests for personal examinations and surveys is greater than can be met by the drainage staff, so it is necessary to select with care those projects which are most representative, and in localities where land-owners are most willing to cooperate and to carry out the work that may be found practicable.

The work is done under the immediate direction of C. G. Elliott, chief of drainage investigations of this Office, and may be classified as follows: (1) The improvement of farm lands already under cultivation, which is considered of equal importance with the recla-

mation of uncultivated areas; (2) the drainage of swamp lands permanently too wet for agriculture; (3) the protection of land periodically overflowed, the cultivation of which is thereby rendered uncertain; (4) the drainage of irrigated lands once profitable, but which have been injured by seepage or by the accumulation of alkali; (5) the collection of data of service to engineers and others in planning the improvement of lands for agriculture; and (6) the dissemination of the information secured.

A summary of the principal projects carried on during the past fiscal year under each of these divisions is given herewith.

IMPROVEMENT OF FARM LANDS.

A survey and plans were made by L. L. Hidinger for underdraining the wet lands on the Berry School farm near Rome, Ga. Pupils of the school, boys from the mountain districts, assisted in the survey, and, with the superintendent of the school, were instructed regarding drainage and the methods of laying tile. For a part of the lines location and grade stakes were set. The drains have been installed by the students according to the plans.

Attempts to drain farm lands in the vicinity of Chadbourn, N. C., have heretofore met with but partial success. A survey was made by S. H. McCrory, and plans were prepared for improving the natural watercourses and constructing new ditches to provide outlets for about 3,200 acres of cultivated land.

H. M. Lynde surveyed tracts on the plantations of S. G. Stoney and J. P. Clark, in Berkeley County, S. C., and prepared plans for the channels necessary to drain about 7,000 acres of wet lands. The improvements will be made by the owners of the property, and will serve as an example to other owners of similar lands in that part of the State.

The farm of L. S. Rogers, near West, Miss., was surveyed. For the wet area there was planned a complete system of underdrainage supplemented by levees to prevent overflow by water from adjoining lands.

An experimental system of tile drainage was planned for 26 acres on the farm of H. K. Knox, near Baton Rouge, La. The drains will be installed by the landowner, to determine the feasibility of tile drainage in the heavy alluvial soil of that vicinity.

DRAINAGE OF SWAMP LANDS.

During the winter a survey was made under the supervision of A. E. Morgan to secure data for preparing a comprehensive scheme to drain about 1,000,000 acres in the St. Francis Valley, in Arkansas. The area includes about the eastern half of Craighead and Poinsett

counties and the whole of Mississippi County. As the merchantable timber is removed, there develops a desire to fit the land for agriculture. Plans for the drainage of some parts of this area have been made, but the low elevation of the land and small slope of the surface make necessary the treatment of the whole as one district. The complete plan is now being prepared.

G. A. Griffin made a survey of Cedar Swamp, in southern Delaware, planned the necessary drainage ditches to reclaim 6,000 acres, and reported a plan and estimate of cost for reclaiming the lands for cultivation. Examination was made of the feasibility of improving the Pocomoke River, in Maryland, as an outlet for this swamp and for the 1,300 acres of wet lands along the stream.

Lake Mattamuskeet and adjacent lands, in Hyde County, N. C., were surveyed by S. H. McCrory under the supervision of J. O. Wright. The area of the lake is 50,000 acres, it is about 5 feet deep, and the mean elevation of its surface is approximately 2 feet above sea level. Plans have been made for ditches and a large pumping plant to drain the lake and 70,000 acres of the surrounding land. Steps are being taken to organize the district and carry out the plan.

A survey was made by H. M. Lynde, and plans have been prepared for draining 14,400 acres lying south of Moyock, N. C. The district includes some lands that have been cultivated and swamp lands on the edge of the Great Dismal Swamp that are being cleared of timber. Water from the swamp overflows the land, the ditches already constructed being insufficient to remove it promptly. The plans prepared recommend the improvement of the old channels and the construction of new ones that will intercept this overflow and provide adequate drainage outlets for the district.

Under the supervision of J. O. Wright, surveys and examinations were made of 15,000 acres drained by Pantego Creek, in Beaufort County, N. C. The ditches as planned are now being constructed.

RECLAMATION OF OVERFLOWED LANDS.

The survey begun by L. L. Hidinger in 1907 in the Little Wabash Valley, in Illinois, was extended to include the overflowed lands on the Skillet Fork, and the field work has been completed. Levees and ditches have been planned to protect from overflow 53,000 acres on the Little Wabash River and 75,000 acres on the Skillet Fork, and to provide drainage channels for the protected lands.

A survey of Logan Creek in six counties of Nebraska, from Wakefield to the Elkhorn River, was made by Lawrence Brett; the bottom lands to be drained are about 53,000 acres. New channels have been designed for a considerable part of the distance to relieve the main channel and to provide drainage for the lowlands back from the

creek. The report has been transmitted to the boards of county commissioners and to the officers of the provisional drainage organization.

Under the supervision of W. J. McEathron, S. H. McCrory made a survey of the flooded lands along the Vermilion River in Turner and Clay counties, S. Dak., obtained gagings of the flow during a period of very high water, and prepared plans for the levees and ditches that will be required to protect and drain 18,000 acres.

The Mulberry River, in Jackson County, Ga., is typical of the smaller streams in the South, which are crooked and obstructed and therefore do not remove the excess rainfall quickly enough to prevent injury to crops. L. L. Hidinger made a survey to determine the feasibility of improving this stream, and planned the work necessary to give the channel sufficient capacity to prevent overflow and to drain the fertile bottom lands.

Under W. J. McEathron's supervision, H. A. Kipp conducted a survey of lands drained by Silver Creek, in Merrick County, Nebr., which are typical of the bottom lands of the Platte River. The old channels are so tortuous and obstructed that entirely new straight channels have been designed which will drain the 50,000 acres now subject to overflow.

Examinations were made of the lands inundated by flood waters from White River, in Jackson County, Ark. Lines for proposed levees were located along this river and along Village Creek, and ditches were planned to protect and drain 26,000 acres now largely unproductive.

Under the supervision of A. E. Morgan, F. F. Shafer examined some 270,000 acres in Lawrence, Randolph, and Jackson counties, Ark., drained by Village Creek and Running Water Creek. Surveys were made and plans and estimates were prepared for reclaiming 56,000 acres by ditches, new channels, and some short levees along Black River.

This Office directed the survey of about 180,000 acres in Jefferson and Arkansas counties, Ark., for the reclamation of the wet and overflowed land along Plum Bayou and Bayou Meto. The plans have been prepared by local engineers and submitted to this Office for examination and approval.

S. H. McCrory has made a survey of Salt Creek, in Nebraska, from above Lincoln to the Platte River, near Ashland. The congestion of flood waters at Lincoln, and the necessity of including valuable city property in the district, make the problem one of unusual difficulty, requiring the greatest care in determining the most practicable design. The plans will outline the work necessary to control the floods and protect about 26,000 acres of agricultural land.

J. V. Phillips has made a survey and located the line for a short levee along Cape Fear River, in Bladen County, N. C., to prevent

the inundation of Lyon Swamp. He also prepared a plan for the drainage of the swamp comprising 6,000 acres.

A survey has been made by H. A. Kipp to determine the work necessary for protecting against annual overflow and draining the bottom lands of the Tuscumbia River, in Prentiss and Alcorn counties, Miss., amounting to 23,000 acres.

The report of D. G. Miller, giving plans for levees to protect from overflow lands in Richland County, S. C., on the Congaree River, below Columbia, has been revised to provide against floods equal to that of 1908, and has been transmitted to the landowners most interested.

DRAINAGE OF IRRIGATED LANDS.

The work of drainage investigations in the irrigated lands of Utah and Colorado has been done under the supervision of C. F. Brown, who has been assisted by R. A. Hart, D. G. Miller, and H. R. Elliott. Many localities have been examined and drainage plans outlined. Surveys have been made, and the construction of the drains watched and directed, in order to study the movement of the water in the soil and to learn how it can best be intercepted or removed. Such surveys have been made of several new tracts in Utah. Plans were prepared for a district of 1,000 acres near Venice, and examinations were made of injured fruit lands in the Green River Valley near Vernal. On the tracts in Emery and Washington counties, where previous efforts of this Office have been but partially successful, further studies are being conducted.

Plans have been made for the drainage of a number of tracts in western Colorado in the vicinity of Grand Junction, Delta, and Montrose. The drains are installed by the landowners, and the injured areas are being reclaimed in almost every instance. A drainage survey was made of the California Mesa, near Delta, showing the areas needing drainage, and general plans will be made for improving these lands and preventing further injury. The investigations in the San Luis Valley have been continued, where the interest in drainage is rapidly increasing.

C. G. Elliott visited Yakima County, Wash., to examine the Wapato irrigation project in company with the Reclamation Service engineers. A drainage plan was submitted to the Department of the Interior for reclaiming the 43,000 acres of this project now injured by seepage and alkali, and for keeping other lands from being affected.

L. L. Hidinger has made investigations of conditions in the Rio Grande Valley in Texas, where the need of drainage is being forced upon the attention of all people interested in agriculture. Low areas have become saturated with water from higher irrigated land, and in

many places the accumulation of alkali is destroying the useful plants. To remove the alkali and the excess water thorough drainage is necessary. General reports of the conditions have been made to the Office, and surveys of some of the tracts most injured have been made, from which have been prepared drainage plans to be submitted to the owners.

COLLECTION OF DATA ON DRAINAGE.

C. G. Elliott spent two months investigating drainage practice in northern Europe. He visited the fen lands of England, examining soil conditions, pumping plants, and the arrangement of ditches. Data were also gathered relating to the depth of water removed, the methods of treating peaty lands, costs of construction and maintenance, and the terms upon which government loans for drainage improvements are made to landowners. Drainage works in northern France were inspected, and interviews were obtained with officials of the boards of agriculture of France and of Belgium. In Holland investigation was made of the drainage of Haarlem Lake and of the cultivation of the lake bed. Moorlands and other drained areas were visited in north, west, and south Germany, and in the vicinity of Salsburg, Austria. Although both climatic and industrial conditions in Europe are different from those in the United States, the long experience of these older countries is of much value in planning drainage improvements here.

Further investigations have been made of drained peat and turf lands in the upper Mississippi Valley, regarding the methods of drainage employed, the treatment required to fit such lands for cultivation, and the kind and value of crops obtained. Similar investigations have been begun in southern Louisiana by A. M. Shaw, special attention to be given to finding the amount of water such soils will absorb, the proper moisture content, and the run-off that must be removed by pumping plants. Observations are also being made of the flow of water in drainage ditches.

Geo. M. Warren has made investigations of the drained tidal marshes along the Delaware River. Information as to the amount of drainage works constructed and of their efficiency is being compiled. The action of sluice gates has been studied, the treatment and value of the reclaimed lands, and the crops produced. Some very complete records of costs have been secured.

An examination of drained areas of the Dismal Swamp, in Virginia and North Carolina, was made by H. R. Elliott, who prepared a report showing the extent of the work which has been done by the owners, the results accomplished, and the value of the lands that have been cultivated.

R. A. Hart has made investigations of the effect of alkaline waters upon the setting, strength, and durability of Portland cement, with special reference to the use of cement tile in the irrigated lands where certain salts are present in the soil. The cost of clay tile in many localities is almost prohibitive, and cement tile is much less expensive.

DISSEMINATION OF INFORMATION.

Besides much information of general and specific nature given out by correspondence from the Office, and in the typewritten reports upon the various projects, members of the staff deliver addresses to meetings of farmers, engineers, and others interested in problems of agricultural drainage. C. G. Elliott addressed a meeting at Tallulah, La., called by the levee board to consider the drainage of lands in the fifth Louisiana levee district. S. M. Woodward delivered a series of three lectures before the Graduate School of Agriculture, Cornell University, at Ithaca, N. Y. Meetings of farmers and other landowners were addressed by the supervising drainage engineers at Princess Anne, Md.; Georgetown, Del.; Osceola and Lake City, Ark.; Fremont, Nebr.; and several towns in North Carolina. The supervising engineers assisted in drafting the new general drainage laws passed by the legislatures of Arkansas and North Carolina.

THE PROMOTION OF AGRICULTURAL EDUCATION.

In 1909, as in years closely preceding it, much attention was given by college and school authorities in this country and abroad to the promotion of agricultural education. At the first convention of the Pan-American Scientific Congress in Chile the programme of the section on agronomy and zootechnics was largely taken up with discussions on agricultural education. In Canada much attention was given to the establishment and building up of institutions for agricultural education, including an agricultural college in Saskatchewan, and particularly to the development of courses for the training of teachers of agriculture and home economics. Teacher training was also actively promoted in Ireland, where efforts have been made for a number of years, through fixed agricultural schools and various forms of itinerant instruction in agriculture, to reach the people in all parts of the island. In England the University of Manchester established a three-year course in agriculture, leading to a degree in science.

In the United States the country life commission appointed by President Roosevelt collected a large amount of valuable data concerning the status of education for rural people and recommended the general development and extension of facilities for the teaching of agriculture, home economics, and other country-life subjects. The

third session of the Graduate School of Agriculture at Cornell University was the most successful yet held. Plans have been made for the fourth session at the Iowa Agricultural College, and the director of this Office has accepted an invitation to act as dean of this session. Graduate schools offering courses in agriculture were established in connection with the agricultural colleges in Illinois and Massachusetts.

During the year the agricultural colleges have given instruction in agriculture to more students than in any previous year and have also done more effective work along other lines. Several of the biennial state appropriations for these institutions have approached or passed the half-million mark, notably in Washington (\$487,000), Pennsylvania (\$526,000), and Kansas (\$671,000). The growth of the agricultural colleges is also indicated by the number and character of college buildings completed during the year. Among the more important of these were the following agricultural buildings: Georgia, \$100,000; Iowa, \$400,000; Maine, \$50,000; Michigan, \$175,000; Missouri, \$100,000; and Montana, \$80,000. Wisconsin has completed a \$75,000 live-stock pavilion, and California has started work on a \$200,000 agricultural building. Faculties and courses of study were reorganized on broader lines in Alabama, Arkansas, Georgia, Louisiana, Massachusetts, Oregon, Rhode Island, South Carolina, and Wisconsin; definite provision for training public-school teachers of agriculture or for aiding them through extension departments or special publications is now made by agricultural colleges in twenty-seven States, and fully as many of these institutions are engaging actively in other forms of agricultural extension work. New agricultural colleges have been established in Hawaii and Porto Rico and the former was opened early in 1909.

Secondary courses in agriculture have been established in connection with the agricultural colleges in Montana, Oregon, South Dakota, Texas, and Virginia, two district agricultural high schools have been provided for in Idaho, likewise four in Arkansas with a total appropriation of \$160,000, two more in New York with a total appropriation of \$100,000, and five in Oklahoma, two of which have been located and have received \$20,000 each for buildings and \$12,000 each for maintenance. Subsidies have been voted to encourage the teaching of agricultural and domestic science in public high schools as follows: In Texas, \$32,000; in Minnesota, \$25,000 for ten schools; in Virginia, \$20,000 for ten schools; in Mississippi, \$1,000 for one school in each county; and in Louisiana, \$500 to each school approved by the state board of education. In Massachusetts the Smith Agricultural School and Northampton School of Technology has been opened at Northampton and smaller agricultural high schools at Petersham and Montague.

The introduction of agriculture into the elementary schools has also been promoted actively. In this work the colleges have been particularly active through their summer schools and other teachers' courses and through the preparation of courses of study and school leaflets and the encouragement of boys' and girls' clubs. These clubs are coming to be very effective agencies for interesting young people in agriculture and home making and are now reported from 29 States, with a total membership of upward of 150,000. Agricultural college men have also been active in the preparation of text-books and manuals for secondary and elementary schools. One secondary and 6 elementary texts were published during the year.

In all this work of providing facilities for graduate study in agriculture, reorganizing and strengthening college courses, and multiplying opportunities for acquiring secondary and elementary instruction in this subject, the Office of Experiment Stations has continued to act as the general agency of the Department. The director, as chairman of the committee on instruction in agriculture of the Association of American Agricultural Colleges and Experiment Stations, has aided in the work now being done to prepare a four-year college course in home economics and a one-year secondary course in animal husbandry. He also aided in preparing courses for agricultural high schools and has taken part in a number of important educational conferences and spoken at several large meetings of educators.

The agricultural education service of the Office has continued to be under the immediate direction of Mr. D. J. Crosby, who has been aided throughout the year by three clerical assistants and during the last four months of the year by Mr. F. W. Howe, assistant in agricultural education. The demands upon this branch of the Office for assistance to colleges and schools of different grades, and to teachers and other school officers interested in the promotion of agricultural education have continued to grow more rapidly than the funds for this work have increased, and consequently the better facilities of the Office for assistance to these educational agencies have not enabled it to keep up with the demands. There have been numerous requests to attend conferences and conventions, to outline courses of study for new schools, and to give lectures at summer schools for teachers, but with the pressing current work, the preparation of educational publications, the reviewing and abstracting of the literature of agricultural education, and the management of a large correspondence it has been necessary to refuse many worthy appeals for assistance which would otherwise have received careful attention.

FARMERS' INSTITUTES AND EXTENSION WORK.

The work of the Office in promoting the interests of farmers' institutes has proceeded along the same general lines as in previous years and has continued under the direction of Prof. John Hamilton, farmers' institute specialist.

The growing interest in farmers' institutes and in extension work has greatly increased the work of the Office and has made necessary the appointment of an assistant to the institute specialist; Mr. John M. Stedman, of the University of Missouri, was appointed to the position in May, 1909.

In all of the States, except Louisiana and Nevada, institutes were conducted during the past year, and in all the Territories, except Alaska and Hawaii. In the 47 States and Territories for which reports were received 5,014 regular institutes, with a total of 15,535 sessions were held, with a total attendance of 2,240,925. This is an increase in attendance of about 150,000 over the figures of 1908.

In addition to regular institutes, special institutes were held in a number of States, with an aggregate attendance of over 600,000, making a grand total attendance at all forms of institutes of over 2,850,000. The special institutes included no less than 12 different forms of institute activity, among which were women's institutes, round-up institutes, railroad specials, movable schools, and various other forms.

Among the more marked developments along institute lines are the railroad specials, which are now conducted in 15 States. These specials are equipped with illustrative material and provided with a corps of lecturers who address audiences of farmers at the local stations on the lines of the road. One hundred and fifty-five thousand persons were reported in attendance upon these trains during the past year and had opportunity to hear the lectures and examine the exhibits illustrating the practical value of the instruction given.

Normal institutes for the instruction of institute lecturers have become common and are now regarded as necessary adjuncts to every well-organized institute system.

Movable schools, continuing from one to two weeks in a locality, seem destined to become leading features in future institute development. This Office has aided in this movement by preparing courses of study suitable for use by such schools and by publishing a circular giving specific directions for their organization.

Institutes specially for women are rapidly being organized and in all probability will soon equal in number of members and in effectiveness those established for men. In their development this Office has endeavored to assist through a circular calling attention to

their importance. This circular also outlines methods by which such institutes may be organized and successfully conducted.

The state appropriations for farmers' institutes were about \$20,000 greater than for 1908, making a total of \$345,600.

For the past four years the Office has been cooperating with the standing committee of the Association of American Agricultural Colleges and Experiment Stations on extension work by assigning the institute specialist to act as secretary of the committee. The work of this committee has been very effective and was recognized by the association at its recent meeting in Portland by adopting at the suggestion of the committee a change in the constitution of the association, whereby a third section, to be known as the section on extension work, was created. The association, therefore, now consists of three sections—the college section, the experiment station section, and the section on extension work, thus recognizing extension work in education as coordinate with that of the college in its interior work, and the station in its work of investigation and research. This is a most important step in advance in agricultural education, and in securing its recognition this Office has to some extent shared. Agricultural extension now has, therefore, a recognized place in the educational system of instruction by the land-grant colleges and will undoubtedly offer a field for investigation along agricultural education lines that can properly be undertaken by this Office. The field is new and consequently undeveloped. There is need, therefore, for securing and disseminating information in this direction. The Office can materially aid this movement by organizing a clearing house in agricultural education extension, to which questions of administration and organization in extension work may be referred and where researches and demonstrations in agricultural education extension may be conducted.

The detailed report of the farmers' institute specialist will be found on pages 327-359.

PUBLICATIONS.

As in previous years, the publications of the Office during 1909 may be grouped under five main heads, as follows: (1) Annual reports, including the administrative report of the Director and the larger annual report of the Office. (2) Experiment Station Record, which gives a technical review of the current literature of agricultural investigation throughout the world, and Experiment Station Work, which is published periodically in the Farmers' Bulletin series of the Department and gives a popular summary of some of the more salient practical results of the work of the experiment stations. (3) Publications relating to the food and nutrition of man, consisting of technical and popular bulletins, circulars, etc., reporting or based upon the results of nutrition investigations conducted under the

auspices of the Office. (4) Publications relating to irrigation and drainage, which include reports, technical and popular bulletins, circulars, etc., giving the results of the irrigation and drainage investigations of the Office. (5) Educational and other publications, including those relating to agricultural education in general, farmers' institutes, proceedings of the Association of American Agricultural Colleges and Experiment Stations, and of the Association of Farmers' Institute Workers and similar publications, and the card index of experiment station literature, besides miscellaneous documents of various kinds. The editorial management of the publications of the Office, with the exception of the Experiment Station Record, is in charge of Mr. W. H. Beal.

During the fiscal year ended June 30, 1909, the Department published 57 documents prepared by this Office, not including revised reprints, separates, etc., aggregating 3,412 pages, as compared with 68 documents aggregating 3,839 pages the previous year. These documents included 16 numbers of the Experiment Station Record, 14 technical bulletins, a bulletin of the Porto Rico Experiment Station, 2 reports of the Office, 6 Farmers' Bulletins (including 5 numbers of Experiment Station Work), 5 circulars, 12 monthly lists of experiment station publications, and a farmers' institute lecture. Two other numbers of the Experiment Station Record, 4 technical bulletins, 1 annual report of the Office, 3 Farmers' Bulletins, 1 article for the Yearbook of the department, and several miscellaneous documents, containing about 1,150 pages, were prepared and submitted for publication before the close of the fiscal year. Thirteen separates of individual articles contained in larger reports aggregating 463 pages, were reprinted in editions of varying size to supply requests for the articles.

Several of the earlier technical and Farmers' Bulletins prepared in this Office were exhausted during the year and were reprinted, with more or less important additions and corrections.

It will be noted that there was a considerable reduction in the number and volume of the publications issued by the Office during 1909 as compared with the previous year, and this was brought about in the face of a steady growth in the work of the Office and in the demand for its publications by an earnest effort to reduce the publication work just as much as efficient performance of the functions of the Office would permit.

Experiment Station Record was issued as heretofore under the editorial management of Dr. E. W. Allen.

The plan of publishing the Record was, however, changed so that hereafter two volumes of smaller size will be issued in place of the single annual volume. Each volume will include six regular numbers, two abstract numbers, and an index number, and this arrange-

ment will provide considerably more space for the publication of reviews of work in agricultural science. The amount of this material is increasing, and in the space formerly available it was found impossible to keep the reviews published up to date. The editorial staff was reorganized and strengthened during the year.

The requests for the *Record* from private individuals have greatly increased in recent years, and, as might be expected, an increased demand has resulted from the opening of new agricultural schools and courses. A larger call has likewise come from department men and from branches of the Department located away from Washington. This gain has made it necessary to scrutinize very carefully the requests which have come, especially those from individuals, and to adhere strictly to the limitations of the free distribution of this journal. All requests from individuals not directly connected with agricultural investigation in this country or collaborating with the Department are referred to the Superintendent of Documents, through whom subscription may be arranged for.

A large call for back numbers of the *Record* has come from libraries and station workers who are attempting to complete their files for binding. The supply of these earlier issues is very limited and quite fragmentary, but it has been materially increased by duplicates returned by libraries and individuals who appreciate their scarcity and value. In this way the numbers have been put into the hands of persons who especially prize them, and who could not procure them otherwise. The *Record* is yearly increasing in popularity and in value as a source of information on the progress of agricultural experiment and research, and its files now furnish a record of such work not to be found elsewhere, which is of great importance to investigators who are looking up a subject and planning their work.

The demand for the *Record* from abroad increases steadily, and many warm expressions of appreciation of it come from that quarter. Request has come from the *Annales de l'Institut National Agronomique*, the organ of the French experiment stations and laboratories, for permission to translate from the *Record* articles of special interest to that country. This request was granted, and the journal has reprinted large portions of the *Record* entire. By reason of this new source of material, as the editor of the *Annales* explains, it is now being issued monthly instead of bimonthly. Its comments on the character of the *Record* have been most appreciative. A scientific society in Hungary has lately requested an exchange of the *Record* with its journal, and has offered to translate for the *Record* articles on agricultural chemistry and similar matters. The Department now receives over 130 periodicals in exchange for the *Record*, many of which are foreign. These exchanges aid materially in keeping the

review comprehensive, and represent a considerable saving in expense to the department library.

Experiment Station Work was issued as usual under the editorial direction of Mr. W. H. Beal. This series of publications in a measure supplements Experiment Station Record by presenting the more practical results of the experiment-station work. There has been a large popular demand for these bulletins. During the past year most of the earlier numbers of the series were reprinted.

The report of the Editor and Chief of the Division of Publications shows that about 2,550,000 copies of publications presented by this Office, of which 2,180,000 copies were Farmers' Bulletins, were issued during the fiscal year ended June 30, 1909.

INCOME.

The income of the Office during the past fiscal year, derived wholly from appropriations by Congress, was as follows:

For the general business of the Office.....	\$64,620
For the Alaska experiment stations.....	26,000
For the Hawaii Experiment Station.....	26,000
For the Porto Rico Experiment Station.....	26,000
For the Guam Experiment Station.....	5,000
For investigations on agricultural schools and farmers' institutes.....	10,000
For nutrition investigations.....	7,000
For irrigation and drainage investigations.....	150,000
Total.....	314,620

WORK AND EXPENDITURES OF THE AGRICULTURAL EXPERIMENT STATIONS.

By E. W. ALLEN.

REVIEW OF THE YEAR.

Interest in various forms of agricultural experimentation and the diffusion of results arising from it becomes more active and widespread each year. This is noticeable in the attention which agricultural experimentation attracts in the public press and popular magazines, in the popularity of demonstration trains, in the establishment of local experimental agencies, cooperative experimentation, and the like, as well as in the larger appropriations which are being freely granted for suitable buildings for the stations, for maintenance, and for special lines of work.

A feature of the popular interest in this movement is furnished by the attitude of the railroads. Their interest in the promotion of agriculture has been exemplified in various ways in the past by the operation of trains over their lines for demonstration and institute work, the giving of prizes and scholarships in agricultural colleges, and in some cases in cooperation with the station authorities. Recently one of the large railroads operating in the East has purchased a farm in the State of Delaware, to be used for demonstration purposes to illustrate the renovation and utilization of farm land. In addition, the experts in charge of the farm will take part in institute work, furnish exhibits, and in other ways assist in the promotion of better farming. The same road arranged a special trip for 24 of its local station agents to the Pennsylvania College and Station, where they spent a day in the study of agricultural matters of benefit to the farmers in the districts tributary to their stations, and were brought into closer touch with the work of the institution and the means by which farmers may take advantage of it.

The president of another large railroad system in the East has announced the policy of establishing several demonstration farms to indicate what can be done with reasonable expenditure and intelligent management on farms now largely out of commission. The road has purchased one run-down farm for that purpose and plans to buy others in the near future. As these farms are brought up they will be offered for sale and others purchased. A similar plan has been

proposed by still another railroad, which offers to buy one or more abandoned or run-down farms in New York State to be turned over to the State Board of Agriculture or the New York college or station for operation as demonstration farms, in order to carry the results of their work and experience into practice. In neither case have these railroads large areas of land to dispose of, as some of the western roads have, but the movement is promoted by a faith in agriculture and a realization of the necessity for introducing better and more intelligent methods of farming.

In Arizona a railroad has made an initial contribution to the station of \$2,000 for studies in dry farming. A location has been selected on a tract representative of a large section which it is thought may be utilized for dry farming. The work is to be done under the supervision of the station agriculturist. A large railroad in the Northwest is instituting a series of cooperative farm experiments in conjunction with various development and commercial clubs along its line. A farmer is to be selected near each town, who will be paid at the rate of \$10 per acre annually for cultivating and cropping at least 6 acres of land under the direction of an expert of the road.

The popularity of demonstration trains has not waned, and the character of such trains has become more comprehensive year by year. The practice has extended to every part of the country. As an example of the scope and character of these trains, a demonstration train operated in Oregon may be cited. This train consisted of seven cars, equipped with a large amount of illustrative material, and was manned by a corps of experts from the college and station staff. Demonstrations were given of the milking machine and other dairy appliances, using pure-bred cows from the college herd; and also of pruning, grafting, and packing apples; talks and exhibits on farm crops, insects, and fungus diseases, and other phases of agricultural work. Much interest was aroused among the merchants, commercial organizations, and the general public, as well as among farmers, and in many towns the stores were closed during the time the train was at the depot. During the trip of about a week over 20,000 people visited the train.

In another trip of four days, in which the special features emphasized were horticulture and poultry raising, fully 30,000 people were reached. A fruit-demonstration train operated in the Yakima Valley in Washington included a flat car equipped with a model orchard in tubs and a power sprayer, by means of which complete demonstrations of spraying and pruning were given. Another train in that State included specially equipped cars for dairy stock, with a milking machine in operation; a dairy car containing bottling appliances, milk coolers, separators, and similar devices; a horticultural car; and a poultry car.

While these means of popular demonstration work have reached their height in the Western States, they have also been very successful in the East, where the steamboat has been pressed into service to reach farmers not located on the railroads, and in several instances special electric cars have been equipped to run over a network of electric lines reaching into the rural districts. The railroads have continued to run excursions to carry farmers and their families to the institution. An illustration of this was an excursion run in New Hampshire in the summer of 1909 through the agency of the station, which brought about 3,000 people to the institution in a single day. This is stated to be the largest agricultural gathering ever held in that State.

In Minnesota the legislature has appropriated \$50,000 for the biennium for extension work, which is to embrace, among other things, popular bulletins giving the results of work at the station and its branch stations. A novel form of extending information to dairymen has been put into effect by the Wisconsin University and Station under the name of the "postal dairy library." A topical list of bulletins and articles on dairying has been made up, which is circulated among dairymen, who may make selections from it to be loaned for reading.

"Farmers' week" has become an established feature at several institutions, and is increasingly popular and largely attended. This is partly educational, but from its nature the station has quite a prominent part in it, and the farmers, young and old, are brought into direct contact with its work. Through this means they come to know the station better, to appreciate its objects and methods, and have an interest aroused which makes its work and its publications far more valuable to them. The attendance on "farmers' week" has reached up into the thousands in several cases.

SUBSTATIONS AND LOCAL TEST FARMS.

Increased activity is shown in the States in making provision for permanent substations, or for temporary branches to serve in the investigation of special problems. The last legislature in California provided \$6,000 for the biennium for a substation in the Imperial Valley, which has been located at El Centro. It will study especially the problems of irrigation in that region. In Colorado the substation at Cheyenne Wells has been revived with a state appropriation. In Idaho the State has provided for three substations, one for dry farming, another for irrigation, and a third for the cut-over regions. A special station for rice culture has been started in Louisiana through cooperation of the central station and the United States Department of Agriculture with local agencies.

In Minnesota 12 demonstration farms of 80 acres each have been established, and plans are being made for 7 additional farms. The State Federation of Commercial Clubs is actively cooperating in this enterprise, and a special feature of this is to be the foundation of a farmers' club in each locality adjacent to the farms, to hold meetings for the general discussion of agricultural problems. In Nebraska a successful substation has been in operation for some time at North Platte, and a second station has now been authorized, \$15,000 being appropriated for the purchase of land and maintenance for two years. The State of Nevada has appropriated \$10,000 for a farm in the northeastern part of the State for dry-farming experiments, to be conducted under the supervision of the station, and in North Dakota 9 additional demonstration farms were opened the past year with funds received from the State. Field work was instituted upon the substation at Langdon, and the station for the Hettinger district was definitely located. The substation provided for in west Tennessee by the legislature of 1907 has been located near Jackson, a farm of about 175 acres having been donated by the county. Buildings have been erected, an orchard set out, and field work started. An appropriation of \$10,000 has been made for this substation, and \$5,000 for conducting experiments in middle Tennessee; and in Texas, where the last legislature appropriated \$50,000 for the establishment and equipment of substations, 7 have been located, 2 of which will give considerable attention to rice culture. The localities assisted liberally in providing these stations with the necessary lands and buildings, in some instances donating the land outright and erecting the necessary buildings and improvements.

In Maine a farm for investigations in orcharding and field crops, authorized by the last legislature, has been purchased. This farm is located some distance from the central station, and although directed from it will be analogous to a branch station. It contains 225 acres of land, of which 100 acres are well adapted to tillage and 60 acres are already set to orchards. It is equipped with modern buildings. In Oregon a dry farm of 220 acres was established at Moro, Sherman County, with a state appropriation of \$5,000 for the biennium, supplemented by an equal amount by the Bureau of Plant Industry of this Department. Horticultural work on the Umatilla project experimental farm, at Hermiston, was begun with an appropriation of \$6,000 for the biennium, supplemented by an equal amount by the Bureau of Plant Industry.

The first county demonstration farm in Missouri to be undertaken under the act of 1907 has been established in Jasper County. The station and the county court exercise joint supervision of such farms. A tract of 20 acres has been leased, and demonstrations are in progress, with crop rotations and the use of fertilizers and green manures.

Temporary field trials are also under way at about 20 other branches in the county, in tests of the adaptability of different varieties of grasses and cereals to the various soil types. An expert from the station is in charge of this work, and devotes his remaining time to assisting the farmers of the locality in applying improved methods of agricultural practice. Plans are on foot for the establishment of similar demonstration farms in two other counties, in one of which special prominence will be given to fruit and vegetable growing. There are now 92 cooperative experimental fields in 114 counties of the State.

The Ohio Station has accepted an offer made by the vestry of a church in Mahoning County of the use of a tract of 10 acres for field trials, and a similar offer from the county commissioners and the agricultural society of Hancock County, where 20 acres have been provided. Work in both places is already under way.

The Wisconsin Station has made arrangements to conduct systematic demonstration experiments at the farm of the state insane asylum at Viroqua. It is planned to extend the work to the farms of other state institutions, with a view to providing object lessons for near-by farmers, as well as establishing distributing centers for improved seeds and other material sent out from the college and station. The past year 13 county poor farms cooperated with the department of agronomy of the station in growing and testing pure-bred seeds for demonstration purposes. The Minnesota Station has leased a farm for five years for the purpose of carrying on experiments in quack-grass eradication.

The above shows the extent and variety of form which these popular efforts are now taking. They indicate the attempt made to reach and assist the farmers, and the interest the latter take in agricultural experimentation.

Experimental unions, composed in some cases of the graduates of an agricultural college and in others of any farmers interested in the subject, are doing effective work in some half dozen States. Such work is conducted in cooperation with the station, which acts as the leader and often exercises supervision over it. Frequently an annual meeting of the experimenters is planned to discuss the results of the work. Such experiments and trials are in part a demonstration of facts already ascertained, but in some cases have real experimental features and serve the double purpose of securing experimental results and of teaching the farmers how to experiment for themselves. The scope of such work and its experimental value are, of course, limited, but in instances where the station exercises a supervision over the trials through an assistant who goes about among the experimenters results of considerable value may be secured, and the findings of the station on its own plats are given a wide test under quite a variety of conditions.

In Rhode Island, where an experimental union was formed by the station a year ago, over 100 cooperators conducted experiments the past season under the general oversight of the station. In Wisconsin this enterprise has assumed such proportions that the organization of county branches of the State Experiment Association is being undertaken with a view to close supervision of the experiments and greater specialization in planning tests to meet local conditions.

THE SPECIAL FIELD OF STATION WORK.

While the various popular features mentioned above broaden the field of usefulness of the experiment stations, they often make new demands upon them which it is difficult to meet, and they increase the danger of scattering the energies of the station staff. It is now generally recognized that the members of the staff should be left to give their time primarily to experimenting and research; and the extension and demonstration features have reached a point where special provision needs to be made for them. The interest and thought which the subject is receiving from college and station men was evidenced by the attention given to it at the convention of the American Agricultural Colleges and Experiment Stations at Washington in the fall of 1908 and at Portland in the summer of 1909. The evident conviction in the minds of many members was that such work should be more definitely provided for and should be separately organized.

The growing importance of this matter has made it necessary for the Office to give much attention to it during the past year in the administration of the station funds. The increased activity of the stations in that direction has brought with it new problems relating to the organization of the work and the relation of the station force and funds to these enterprises. A clear differentiation of extension work from the accepted forms of station activities is not always a simple matter, and it is often difficult to determine what publications should be issued by the extension department as distinguished from the stations. The fact that the stations have the franking privilege while the extension departments do not has easily led to the inclusion in the list of station publications of many which are not in any true sense reports of experimental work.

The confusion has been increased by the fact that legislatures granting funds for extension work have in many cases so worded the appropriation acts as to put the money under the control of the stations. This has led to a feeling in some quarters that such work is appropriate for the stations, and that they ought to retain and develop it. The federal funds given to the stations are very apt to become involved in extension work when it is done under such circumstances. The services of station officers paid from the federal

funds are often desired for extension work. Printing of what are really extension documents is paid for from the Hatch fund, and miscellaneous expenses are laid upon these funds which would not have been incurred but for the pressure for extension work.

It has therefore been necessary to make a closer scrutiny of the station accounts with reference to this matter and to insist that full provision be made to charge all extension expenses to other funds. This matter has been made the subject of a circular letter to the stations, issued in February, 1909, in which the position of the Office with reference to the expenditure of the Hatch fund was defined. Notice was given that expenses for extension work should not be charged against the Hatch fund, and that only such printing should be done with that fund as will record the experimental work of the stations established under the Hatch Act. This rules out compilations, bulletins of substations, and a variety of publications which are useful in extension work but are not included within the terms of the Hatch Act. The stations were urged as far as was necessary to change their policy of expenditure of the Hatch fund so as to devote a large share of that fund to definite experimental work, restrict the expenditures for printing as indicated above, and put miscellaneous and administrative expenses as far as possible on other funds.

The public and their representatives in legislatures and administration offices do not yet fully understand the magnitude of the enterprise involved in bringing home to the millions of men and women on the farms the results of the work of scientists and practical men for the improvement of agriculture and the general conditions of country life. The officers now employed in the agricultural colleges and experiment stations can not do this work in any large way. It is true that they have in the past done much to show the desirability of extension work in agriculture and to develop the lines for such work. But now that the movement is under way they are overwhelmed if they attempt to carry it.

It has sometimes been felt that the extension departments if separated from the station and organized with a distinct corps of workers would tend to separate the station workers from close touch with the farmers and obscure the importance and value of station work as related to the agricultural industry. This, however, need not be the case if the extension departments are properly organized and manned. The scheme of organization should include the giving of opportunities to station men to attend meetings of farmers from time to time to present the results of station work, and the giving of credit to the stations for whatever information received from them is incorporated in extension publications. The station should not in any case be deprived of the privilege of issuing popular accounts of the results of its experimental work as station publications. The college authori-

ties should take special pains to explain and reiterate to the public that the station is the source of new knowledge, while the extension department is an agency for disseminating information. By maintaining this distinction the position of the stations as research institutions will be made stronger and more satisfactory than at present, or than it can ever be while they are performing such miscellaneous functions as they now do in most cases.

The extension work increases the demand for experimental work, which is now growing apace. Every reasonable provision should be made to push the experimental work to meet the demand for new information which is arising on every hand. The station and college men have more than enough to do in experimenting and in regular teaching. The extension work should be done without injury to either function, and to meet this provision of funds is necessary wherewith to equip and man the extension departments and meet their expenses for printing, traveling, and other legitimate purposes. The Office has maintained that the federal funds granted to the agricultural experiment stations can not legally or wisely be used for the maintenance of extension enterprises, and is guarding against such use.

INCREASE IN FUNDS AND EQUIPMENT.

Notable additions to the building and equipment of the stations have been made in the past year. The additions to equipment aggregate \$744,561.93, and have been provided quite largely from the federal funds to meet the need of the more exact experiments and researches.

New buildings to be used exclusively for the stations have been provided for and completed in Indiana, Porto Rico, and Texas. The high character of these buildings shows the extent to which the needs of the stations are recognized.

A station building is now under way in Florida, supplied by an appropriation of \$40,000 for that purpose, and in Hawaii the federal station has been allotted funds from the territorial income tax to erect a new office building. This will provide offices for five or six members of the staff, rooms for the library, and storage for the bulletins. The general assembly of Connecticut at its last session appropriated \$30,000 for the building and equipment of a fireproof addition to the station laboratory. This laboratory has since been destroyed by fire, but will be rebuilt with the insurance.

In Alabama, Iowa, Missouri, and New Mexico large, well-appointed agricultural buildings have been completed, which will be used by both the college and the station officers and will provide improved facilities for the latter. An appropriation has been made of \$10,000 for furnishing the new Missouri building, and an equal amount for

a heating plant. The sum of \$10,000 has also been provided for a veterinary hospital at the Missouri Station. In Massachusetts an appropriation of \$80,000 was made for an entomological building, to be used jointly by the college and station. This building is well under way, and promises to be one of the finest buildings yet provided by any of the colleges for a special department of work. A new \$40,000 building for civil and irrigation engineering, to be used by the college and station jointly, was nearly completed in Colorado. The legislature of Delaware appropriated \$10,000 for new buildings on the farm. In Montana \$10,000 was used for constructing a sheep and steer barn, an addition to the poultry plant, and sheds for young stock. The Kentucky Station has purchased a farm costing \$7,000 out of the fees from the fertilizer and feeding stuffs control, and has provided a new piggery with numerous feeding lots. Many other small buildings have been provided at other stations.

A large majority of the States now make special appropriations for the maintenance of the stations or for the prosecution of special features of investigation. Among the new appropriations or those under which the stations worked during the year, the following may be cited as showing the increasing liberality of the States. These amounts are in addition to those given for buildings, some of which are mentioned above:

The territorial legislature of Arizona appropriated \$4,500 for the ensuing two years for the date orchards at Tempe and Yuma, and \$3,000 for dry-farming investigations. The territorial legislature of Hawaii has provided \$10,000 a year for the biennial period, to be used in part to increase the scope of experiments in forage production, crop rotation, soil studies, and plant diseases, and in part for general maintenance, thus liberally supplementing the funds given by the Federal Government. In Illinois the annual appropriation for soil investigations was increased for the biennium from \$25,000 to \$60,000. The increase is to be devoted in part to the extension of the soil survey conducted by the station, which has already been completed in twenty-eight counties of the State. In Indiana the station is working under an appropriation of \$75,000 per year, made a year ago, which is an increase of \$50,000 over the previous appropriation of \$25,000; and in Kansas the present appropriation is \$30,000. The Montana Station was given \$12,500 per year for maintenance, an increase of \$5,000; \$9,000 for dry-farming investigations; and \$8,000 for the substations, which is also an increase of \$5,000 per year.

The Ohio Station received a year ago an aggregate appropriation of \$118,990, an increase of \$25,000, besides an unrestricted amount for paper for publications. That station has for many years maintained its own plant for printing its bulletins and other publications.

The Utah Station received an appropriation, under which it has worked the past year, of \$5,000 for publications, \$10,000 for dry-farming investigations, \$11,000 for fruit investigations, and \$7,500 for irrigation and drainage investigations. Wyoming appropriated \$7,500 for experiments in dry farming.

Special appropriations were also made to the Minnesota Station of \$1,000 each for soil, horticultural, noxious weed, and entomological investigations, \$6,000 for hog cholera work, \$6,000 for a denatured alcohol plant, \$3,500 for the breeding of field crops, \$2,000 for drainage studies, \$2,000 for tobacco experiments, \$400 for plant diseases, \$3,500 for the distribution of entomological charts in public schools, and \$10,000 for the establishment and maintenance of a poultry department. The two substations are given \$11,500 and \$14,000, respectively. A tract of 2,200 acres of land in Carlton County, Minn., has been given by private interests for experimental work in forestry, and the State has appropriated \$2,500 a year for maintenance of a forestry station, together with \$1,500 for experiments in the use of preservatives for timber.

In New York the last legislature appropriated \$10,000 to study the grape industry in Chautauqua County and determine what is needed for its improvement. A tract has been leased for ten years in the expectation that the appropriation will be renewed. Horticultural, plant disease, and insect surveys are being made as a preliminary step. The work is under the state station at Geneva.

The milling and grain interests in Kansas have pledged \$5,000, to which the college will add an equal amount, to be used in the maintenance of a new division of milling industry. This division will investigate the condition of wheat in the fields, insect pests at all stages, damage due to weather, and similar problems. An experimental baking plant will be operated for testing the bread making capacity of flours from different kinds of wheat and for conducting technical experiments in bread making.

The North Dakota legislature appropriated \$5,000 for the study of milling properties of wheat and flour, and the United States Paint Manufacturers' Association donated \$1,500 for a study of paints, particularly their wearing quality on various types of lumber, the influence of inert material or extenders, the effect of diluents in oil, and the use of water. Other state appropriations were as follows: \$30,000 for a veterinary building, \$3,000 for a state serum institute, \$2,500 for seed inspection, \$2,400 for the biennial period of demonstration farm work, \$10,000 for the biennial period for instituting the Hettinger substation, and \$3,000 for walks.

The interest and cooperation of the Pennsylvania Millers' State Association has enabled the station in that State to begin investigations on the milling and baking properties of Pennsylvania grown

wheat. The Washington Station received biennial appropriations of \$4,000 and \$2,500 for cereal investigations and cooperative investigations in irrigation and dry farming, respectively. In Missouri \$15,000 was provided for the soil survey of the State, which has been in progress for several years.

Among the special appropriations for making and distributing hog-cholera serum was \$1,500 in Michigan, \$10,000 in Minnesota, \$10,000 in Missouri, \$6,000 in Nebraska, and \$2,500 in Oklahoma.

In several instances gifts have been made by individuals, localities, or special interests for experimental work. The establishment of fellowships by business firms for the investigation of specific problems is another new evidence of the interest in agricultural investigation. Such a fellowship has been temporarily established at the Cornell Station for investigating the value of commercial lime-sulphur mixtures as fungicides, provided by a firm manufacturing spraying apparatus, which donates \$1,500 a year for two years for that purpose. Another industrial fellowship has been provided for in that institution, limited to two years, and has for its purpose the investigation of the diseases of nursery stock, especially fire blight. Care will necessarily need to be exercised in the conduct and publication of such work, to relieve it of any appearance of commercialism, for the stations can not afford to lend themselves to that purpose even with contributed funds.

Provision for printing the station bulletins and reports at state expense is now quite common. This has become an important item with the stations, in the growth of their work, and without other than the Hatch fund for printing the stations are greatly restricted in giving the publicity desirable to their work. Already the burden for printing is heavy on the Hatch fund, and the Office is restricting the use of that fund more closely by ruling out popular bulletins and those reporting the results of branch and substation work. It is felt that the States should at least do their share in providing for printing, and where they take over that expense entirely the funds for experimentation are conserved to that extent.

INVESTIGATIONS UNDER THE ADAMS ACT.

The amount of high-grade investigation under this fund is now large, and the spirit of the act in providing for original research in agriculture is receiving hearty support. Studies upon about 383 projects have been under way during the past year, an average of 8 projects per State, the fund being divided in two States. Several projects have been completed, or have been transferred to other funds, often at the suggestion of this Office, as not being appropriate to the Adams fund in the form which their development was taking.

A considerable number of the old projects have been enlarged in scope so as to involve the cooperation of several departments and thus make the study more comprehensive and thorough. Many of the newer projects are large and expensive, and could only have been undertaken with such a special fund. The simpler problems in agriculture have many of them been worked out, so that the field of investigation now leads into a more intricate and difficult line of investigation. The successful development of these projects requires research ability of a high degree, and calls for considerable amounts of money to give the work the necessary scope and to provide the special apparatus and other facilities which are needed.

Everything considered, the research work under the Adams fund is in a gratifying condition, and has already become a factor of the greatest importance in the usefulness of the experiment stations. As this research is extended to every State and Territory in the Union, great scope is given to the problems under investigation, representing various phases of agriculture the country over.

Efforts in the direction of a concentration of the fund on a small number of projects or independent researches have been continued without abatement. The desirability of such concentration has impressed itself quite generally upon the stations, in some cases as a result of actual experience in which it has been found necessary to drop from that fund some of the projects originally assigned to it. But a tendency still exists among a few stations to overload that fund with an unreasonable and impossible number of projects. Either one of two results must follow such a course—the projects must receive considerable support from other funds, or no real active investigation will result but instead a little work along the borders of the subject, conducted on a scale unsatisfying to the investigator and yielding little of real scientific value. The encouragement by station authorities of such a splitting up of the fund seems to indicate a lack of definite plan for its use, and does not fully take account of the needs of agricultural investigation. The subsidizing of various small undertakings by professors in the college, some of whom have an indefinite status in the station, has little to recommend it, and real agricultural investigation will not be developed in this way. It has already been demonstrated that for productive investigation it is desirable to have a few persons who give their time primarily to it, and with whom investigation is a primary and not a secondary effort.

An important result of the Adams Act has been the remarkable stimulating effect it has had on research in agriculture outside of that carried on under the funds appropriated by the act. It has been the means of building up a strong sentiment for efforts of a research character which are fundamental and scientific in character, and it has developed an interest and belief in agricultural investigation which

has enlarged the opportunity for it and lent stability to the various undertakings. People understand better than formerly that short-cut experiments are often unreliable, and are more patient to await the results of more thorough work.

Everywhere pride in this feature of the stations' work is manifested, and enthusiasm for it among the staff of workers and of teachers. The field is encouraging more men to prepare adequately to enter it, and the standard which it has set is reflected in the requirements for men in other branches of the station work. A considerable number of thoroughly trained men have already been brought into the service, whose work has a clear aim and purpose and who are resourceful in investigating problems requiring high scientific ability. But the supply of such men is still too limited, and not as much progress is being made in the direction of increasing the available supply as the case seems to warrant. Apart from this, boards of control and executive officers have not yet fully understood the requirements of research work, so as to be willing in all cases to call in competent investigators when such men are not already on the station force, or to give them such salary and support and opportunity as makes positions attractive. As one of the station directors recently said in a public address, "If the research and teaching agencies would adopt the policy of employing one three-thousand-dollar man in place of two fifteen-hundred-dollar men, results would be more effective."

STATISTICS OF THE STATIONS.

Agricultural experiment stations maintained in whole or in part by federal funds now exist in every State and Territory, including Alaska, Hawaii, Porto Rico, and Guam. The total amount expended for stations maintained under the acts of 1887 and 1906 during the fiscal year ended June 30, 1909, was \$3,053,446.90, of which \$1,248,000 was received from the National Government. The remainder, \$1,805,446.90, came from the following sources: State governments, \$1,034,803.75; individuals and communities, \$13,199.93; fees for analyses of fertilizers, \$144,326.52; sales of farm products, \$220,001.76; miscellaneous, \$393,114.94. In addition to this, the Office of Experiment Stations had an appropriation of \$314,620 for the past fiscal year, including \$26,000 each for the Alaska, Hawaii, and Porto Rico experiment stations, \$5,000 for the Guam Experiment Station, \$7,000 for nutrition investigations, \$150,000 for irrigation and drainage investigations, and \$10,000 for farmers' institutes and agricultural schools.

In Alabama, Connecticut, Hawaii, Louisiana, Missouri, New Jersey, New York, North Carolina, and Virginia separate stations are

maintained wholly or in part by state funds, and in a number of States substations are maintained. Excluding substations, the total number of stations in the United States is 62, of which 55 receive federal funds.

PROGRESS IN FOREIGN COUNTRIES.

The year has not been especially notable for any important changes or developments in connection with agricultural experimentation abroad. However, several additions to the number of agencies for experimental work and other interesting movements in that direction have been made.

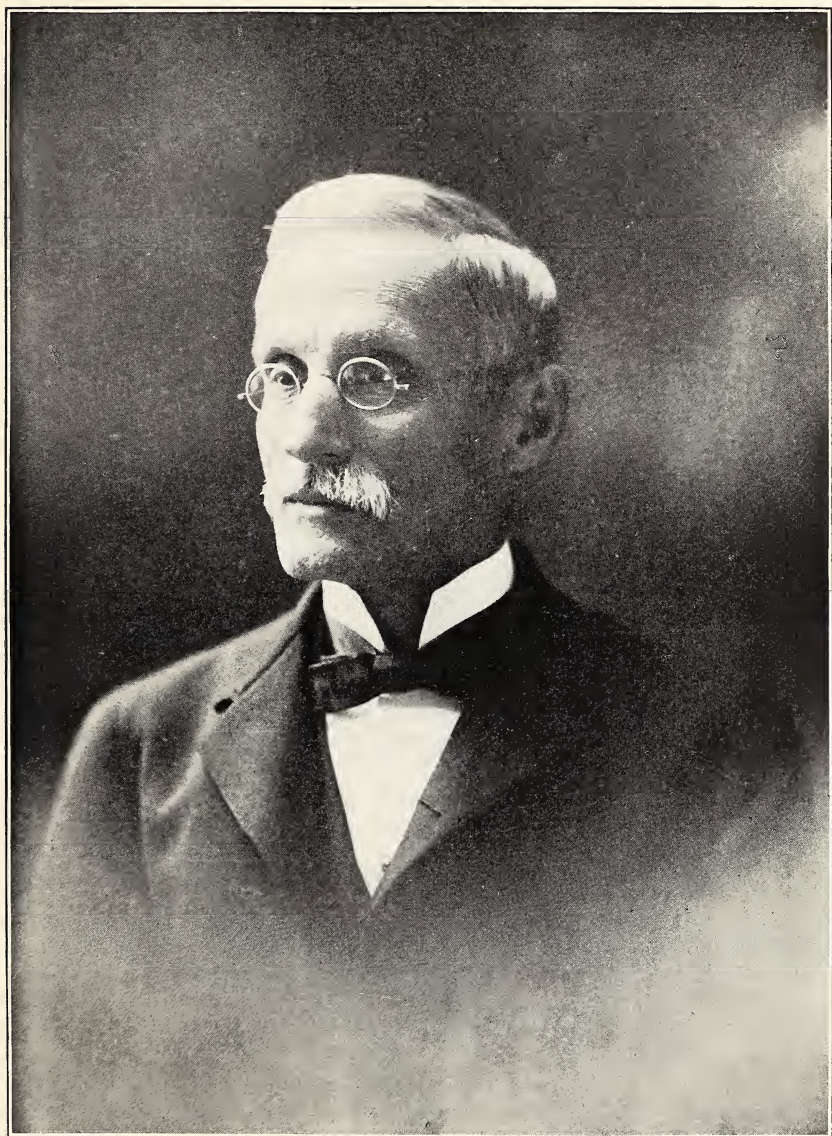
The government of the Province of Tucuman, Argentina, established an experiment station near the city of Tucuman, and secured for director R. E. Blouin, formerly assistant director of the Louisiana Sugar Station.

A scientific committee of 20 on African entomological research has been appointed in England, the object of which will be to further the study of economic entomology with special reference to Africa.

The Government of Brazil is making special effort to develop wheat growing in that country, where it is said to have once been so successful that wheat was exported. Under authority granted by the last Congress, subsidies for a period of five years are being offered for wheat growing, the crop to be planted and cultivated under the direction of government experts, and similar subsidies are offered for the establishment of flour mills for milling wheat grown locally. A bounty of \$6,000 a year for five years is offered to syndicates which combine to establish experiment stations for the study of wheat growing, the control of enemies, and related questions. Considerable interest has lately been displayed by cattle breeders in Brazil in the improvement of their stock. Shows have been held in agricultural centers, and the importation of good animals for breeding purposes is being encouraged by the Government through the remission of the import duty.

Following the change in administration in Cuba, the experiment station was reorganized, the resignations of practically all the foreign members of the station staff being called for and local men appointed.

Experiments in dry farming on the American plan are to be undertaken in Australia. Considerable quantities of grains which have proved adapted to dry lands in the United States have been secured for experimental planting and distribution, and information in regard to American methods has been collected. The South Australian government has purchased 1,600 acres of land for the establishment of a government dairy farm, the object being chiefly to encourage the keeping of improved breeds of milch cows and to demonstrate im-



DR. SAMUEL WILLIAM JOHNSON, JULY 3, 1830-JULY 21, 1909.
Director Connecticut State Experiment Station, 1877-1900.

proved methods of dairy practice. The farm is to be in charge of the government dairy expert.

A new government agricultural station has been established near the city of Oaxaca, Mexico. A large estate is being adapted to its needs and suitable buildings erected.

The government of Madras has opened a new agricultural college and research institution at Coimbatour.

Meat has been added to the diet of the Japanese army, and a commission has been appointed by the Japanese department of agriculture to visit foreign countries to gather information to serve as a basis for the promotion of stock raising in Japan.

Prof. Julius Kühn, a Nestor of agricultural science in Germany, and prominent writer on the nutrition of farm animals, has retired from the directorship of the agricultural institute at the University of Halle, at an advanced age.^a

TWO NOTABLE AGRICULTURAL INVESTIGATORS.

Dr. Samuel W. Johnson, director of the Connecticut State Experiment Station from its organization at New Haven in 1877 until January 1, 1900 (Pl. I), died July 21, after a brief illness, at the age of 79 years.

The name of Doctor Johnson will always be intimately linked with the early history and the development of agricultural science in this country, as it will be with the establishment of the agricultural experiment-station system as an American institution. He was a pioneer of pioneers, a leader of thought, a disciple of a new idea in science. As teacher, writer, investigator, and guiding hand in the administration of the first experiment station, Doctor Johnson exercised a most important influence in developing thought and understanding along the line of the relations of science to agriculture. His greatest work was done before the experiment-station movement became national, and before popular sentiment had embraced the idea of a system of institutions devoted to scientific work in the interest of practical agriculture. But his labors, his studies, and his public utterances prepared the way for the reception of this idea; and the example of usefulness furnished by the station under his direction was a powerful stimulus in propagating this idea and bringing it to fruition in other States. As a teacher of teachers, as a leader in agricultural science, and as a father and promoter of the movement to bring the sciences to the aid of the farmer through the experiment stations, Doctor Johnson rendered signal service to the cause of agricultural advancement, and has left a name to be remembered with great honor.

^a Professor Kühn died April 14, 1910, aged 84 years.

Dr. E. W. Hilgard, professor emeritus in the University of California and director of the experiment station from its establishment in 1875 up to a few years ago, retired from active services in the summer of 1909, under the provisions of the Carnegie Foundation. Doctor Hilgard was another of the foremost pioneers in agricultural science and in the experiment-station movement. Among the very first of the station directors in this country, his writings and influence were potent factors in the extension of these institutions to other States and in the ultimate establishment of a national system of stations under federal aid. The high quality of his work has given it very great value in constructing a science of agriculture. The standards he set for thoroughness, accuracy, and scientific deduction are among the greatest assets of his life work. The tangible product of his labors is shown by the long list of his investigations and their important applications, but the influence of such a man on an embryo science and on the development of investigation is not easily measured.

INSPECTION OF THE STATIONS.

In accordance with the fixed practice of the Office, a personal inspection was made during the year of the work and expenditures at all of the experiment stations receiving government funds. This inspection furnishes first-hand information regarding the progress of these institutions, and affords opportunity for conference with the local station officers, which is exceedingly helpful. Four members of the Office force took part in this inspection; that is, the Director (A. C. True), Assistant Director (E. W. Allen), W. H. Beal, and Walter H. Evans.

The following reports upon the individual stations are based on the results of this inspection, together with the annual financial statements of the stations, rendered on the schedules prescribed by the Secretary of Agriculture, and the printed and other reports received from the station officers.

ALABAMA.

**Agricultural Experiment Station of the Alabama Polytechnic Institute,
Auburn.**

Department of the Alabama Polytechnic Institute.

J. F. DUGGAR, M. S., *Director.*

No particular change in the policy of management of the station was made during the past year. In general, the lines of work pursued previously were continued. F. E. Lloyd was appointed botanist of the station and M. J. Funchess, assistant in agronomy. The new agricultural building, which will accommodate the station as well as

the college work in agriculture, was about completed at the close of the fiscal year.

Progress in all Adams fund projects is reported. In the determination of the fertilizer requirements of a soil for cotton, the plants grown in the field and by the wire-basket method were sampled and analyzed at four different stages of growth. The work for the past two years was confined to potash, and the results showing the difference in composition of the crop when grown with and without potash indicate the need of this element.

A study of the effect of different foods on the quality of pork, especially its solidity, was continued and the data secured were recorded. The studies of the toxic properties of cotton-seed meal were continued by extracting the meal with gasoline and feeding the marc, which proved injurious. Alcohol and aqueous extracts were also made, but no particularly new point was developed. The injurious effects were not produced when materials equally rich in protein were fed.

The entomologist gave most of his time to the project on the factors governing the production, diffusion, and insecticidal efficiency of hydrocyanic-acid gas and carbon bisulphid. During the past year the effects of carbon bisulphid on the germination and viability of grains and the minimum quantity required for killing grain insects were given particular attention. The effect of temperature, moisture, and other factors bearing on the problem were also taken into consideration. Owing to lack of material, little work was done on the life history and economic relations of the fire ant.

In the breeding work with corn and cotton considerable attention was given to the correlation of qualities with each other and with yield. The corn breeding was confined to two varieties, using the ear-to-row method. With cotton the relation between the percentage of lint and the yield of seed cotton was studied. Among other problems considered were the constancy of inheritance by percentage of lint, the influence of the size of seed and the correlation of size or individuality to oil content, and the relation of type of cluster and form of plant to productiveness. Correlations in oats were also studied, and some progress was made in securing hardness and greater rust resistance. For this work about 10,000 seedlings were grown. Extensive records of all plant-breeding work were kept.

With the Hatch fund the Alabama Station pursued work on sirups, cooperative experiments with fertilizers for cotton, variety and fertilizer tests with cotton and corn, experiments on the time of seeding oats, rotation tests, improvement of sweet corn, and the extermination of the cattle tick. In the rotation experiments the results of thirteen years are on hand. Work in animal husbandry included experiments in feeding for beef in cooperation with this Department,

testing the best feeds for wintering 2 and 3 year-olds, and the study of the economy of finishing cattle on southern pastures, supplemented by cotton-seed cake. Pig-feeding experiments were carried on to compare finishing with grain versus grain and green crops, such as soy beans and peanuts. With sheep some feeding experiments to test the effects of cotton-seed meal were made.

In addition to the cooperative work mentioned, the station conducted soil tests with cotton, corn, alfalfa, and other crops in cooperation with farmers, and studied dairy conditions in the State in conjunction with the Dairy Division of this Department.

The following publications of the station were received during the year: Bulletins 143, Feeds supplementary to corn for southern pork production; 144, The San José scale and lime-sulphur wash; and 145, Local fertilizer experiments with cotton in 1895, 1896, 1897, and 1898; Index to Vol. XIV, Bulletins 135-138, and Annual Report, 1906; and Index to Vol. XV, Bulletins 139-141, and Annual Report, 1907.

The income of the station during the past fiscal year was as follows:

United States appropriation, Hatch Act.....	\$15,000
United States appropriation, Adams Act.....	11,000
Total	26,000

A report of the receipts and expenditures for the United States funds has been rendered in accordance with the schedules prescribed by this Department; the salary roll required readjustment before the account could be approved, which left an unexpended balance of \$800 on the Hatch fund and of \$400 on the Adams fund.

The Alabama Station has in hand lines of work which are of great importance to the agriculture of the State, and is making progress; but its general effect is weakened by a lack of unity of action and of directness in the supervision of its affairs. A further differentiation of its work and funds from those of instruction, inspection, and extension is desirable, and a stronger central organization would make the station a more effective agent in the interest of Alabama agriculture.

Canebrake Agricultural Experiment Station, Uniontown.

F. D. STEVENS, B. S., *Director.*

The Canebrake Station continued its work along the same general lines as in the previous year. No changes were made in the station staff, nor in the management of the station in general.

The principal activities during the year were confined to fertilizer tests with cotton, cover crops, and culture trials with alfalfa. The work on the cotton lands showed that the poor, red, prairie upland soils can be maintained or improved by the use of crops for green manuring at short intervals. The profitableness of growing alfalfa

in the Canebrake region has also been demonstrated, and the culture of the crop is being taken up more extensively by the farmers. The results of the soil-improvement work indicate the need of nitrogen and of humus-forming material as well.

Bulletin 26, Fertilizer tests with cotton—Cover crops—Alfalfa yields, was received by this Office during the year.

The income of the station during the past fiscal year was as follows:

Balance from previous year-----	\$1, 087. 56
State appropriation-----	2, 500. 00
Farm products-----	1, 550. 45
Total-----	5, 138. 01

The station receives no federal funds.

The principal objects of the Canebrake Station are to demonstrate the value and profitableness of practical and rational methods of farming, and through these endeavors the institution is growing in popularity and appreciation.

Tuskegee Agricultural Experiment Station, Tuskegee Institute.

Department of the Tuskegee Normal and Industrial Institute.

G. W. CARVER, M. Agr., Director.

The principal experiments conducted during the year included cotton breeding, variety tests with sweet potatoes, soil improvement, fertilizer tests, and trials with forage crops. The cotton-breeding work has given four new promising types. One of these is a long-stapled, upland cotton, and the other three including a wilt-resisting type, are very prolific and suited to certain grades of upland soil. Cultural tests with cotton have shown that deeper plowing than is usually practiced for this crop is desirable, but that on thin soils the depth of plowing must be increased gradually if adequate applications of barnyard manure or of other vegetable matter can not be made along with the proper commercial fertilizers. The station also devoted considerable time to increasing the yield of corn through proper soil management and the selection of seed.

The officers of the station are engaged to some extent in agricultural extension work among the rural people of several counties, but more particularly of the counties near the station.

No bulletins were received from the station during the year.

The income of the station is limited to a state appropriation of \$1,500.

The Tuskegee Station works for the betterment of agriculture in a special field, and the results it secures are appreciated as being of great benefit to farmers in touch with the institution.

ALASKA.

Alaska Agricultural Experiment Stations, *Sitka, Kodiak, Rampart, and Fairbanks.*

Under the supervision of A. C. True, Director, Office of Experiment Stations,
United States Department of Agriculture.

C. C. GEORGESON, M. S., *Special Agent in Charge, Sitka.*

The general policy of the Alaska stations as outlined in previous reports was continued. The most important change was the temporary closing of the Copper Center Station. This was done for several reasons, among them its isolation, which made the transportation of supplies very expensive; insufficient rainfall during the growing season; early frosts, due to the proximity of high mountains; and the desire to develop the Fairbanks Station, where a larger population had already become established.

The station at Copper Center had been maintained for six years, and while some success had been met with in growing cereals in favorable seasons, in other years all grains were destroyed by early frosts. The practicability of growing hardy vegetables in the Copper River Valley was fully demonstrated, and with the rapid settling of the Tanana Valley it was thought desirable to close the Copper Center Station and transfer the implements and movable equipment to Fairbanks, where work was actively begun during the summer of 1909. Sixty acres were cleared and brought under cultivation at this station, a number of buildings were erected, and a portion of the reservation is now fenced. A fairly good equipment of implements and tools has been provided for this station, and it is intended to prove or disprove the possibility of profitable farming in that portion of Alaska.

At the Rampart Station 16 acres are under cultivation, and the past season was a favorable one to all crops. Out of 65 varieties of grain seeded, 57 matured their entire crop, and a portion of the crop of others was ripened sufficiently for seed purposes. The results obtained at Rampart are in line with those of the past eight years, and show that grain can be brought to maturity in the Yukon Valley without serious liability to failure.

The live-stock work is centered at Kodiak, where the Galloway herd has been kept. A portion of the herd is kept near the village of Kodiak and is used for experiments in dairying, while the larger number of animals have been transferred to Calsinsky Bay, where a large tract has been fenced, buildings erected, and the work of cattle breeding installed on a considerable scale. The cattle wintered satisfactorily without any shelter other than that afforded by an open shed. During the summer they grazed on native grasses and were fed during the winter exclusively on hay and silage made from native grasses. Some difficulty has been experienced from an epidemic of contagious

abortion, and a number of cattle died from impaction of the third stomach, although they were fed silage and hay in about equal quantities and were given all the water they would drink.

The horticultural investigations continued to be the chief lines of work at the Sitka Station. Considerable attention is being given to introductions, but the most promising investigations are along the lines of plant breeding. A large number of hybrid strawberries have been produced by crossing a cultivated variety with pollen from the wild species. These plants have been under observation for some time, and some very excellent fruits have been obtained in the first generation. Crosses have also been made between the cultivated raspberry and the native salmon berry, the wild plant being used as the staminate parent. The station is devoting considerable attention to the propagation and distribution of small fruits and is making attempts to secure varieties of apples, cherries, and plums adapted to Alaskan conditions.

But a few changes were made in the personnel of the Alaska stations during the year. Herman G. Zoellner was transferred from the Bureau of Plant Industry of this Department as propagator and gardener, with headquarters at Sitka, and Laurence Kelly was appointed assistant at the stock breeding station at Kodiak. As a result of the closing of the Copper Center Station, C. W. H. Heideman was furloughed at his own request and C. W. Heideman, jr., resigned.

The only publication of the station for 1909 was the Annual Report.

The income of the station during the fiscal year was as follows:

United States appropriation-----	\$26, 000. 00
Farm products-----	3, 612. 23
Total-----	29, 612. 23

The work of the Alaska stations is of great importance in attempting to develop the agriculture of that region. Through their investigations, demonstration work, and distribution of seeds and plants they are performing an important function in determining agricultural possibilities, in aiding settlers, and in determining what plants and what varieties will succeed best in that Territory.

ARIZONA.

Agricultural Experiment Station of the University of Arizona, Tucson.

Department of the University of Arizona.

R. H. FORBES, M. S., *Director*.

Several changes in the staff of the Arizona Station took place during the year ending June 30, 1909. F. C. Kelton was appointed assistant engineer in underground water supply investigations, A. W. Morrill, of this Department, was appointed entomologist, pro-

viding a new active department, and G. F. Freeman, of the Kansas College and Station, as agronomist. J. E. Coit resigned to accept the position of assistant professor in pomology in the California University and Station, connected with the studies of citrus fruit. The principal investigations carried on during the year were generally along the same lines as those of the year before. Definite progress is reported along several important lines of work.

Investigations under the Adams Act are generally well under way and in some instances are either wholly or nearly completed. The project of growing saltbush without irrigation was completed and the results were discussed in the last annual report of the station. The underflow studies have resulted in the demonstration of the amount, availability, and value of an irrigating water supply in a typical desert valley, and in the elaboration of a plan for its beneficial use.

The work on the date-ripening project has not only led to a better understanding of the ripening processes of this fruit, but has also given an economic and commercial method of handling the crop. In addition to indicating the action of enzymes in the ripening process, the results have shown that cutting off the water supply at the right time will cause the dates to ripen, and, in case this factor is not under control, that partial cutting of the fruit stems accomplishes the same result. In the study of the most promising cacti, considered economically and ecologically, particular attention is given to their feeding value in replacing other forage plants in periods of drought, and to the physiological effect these cacti have on animals when fed in quantity on account of their relatively high ash content. Physiological studies with potatoes have shown that by greening and indoor germination of the seed stout shoots are produced, and that by planting this sprouted seed tubers of good size may be obtained before the heat of summer comes on.

The work relating to toxicity of copper upon crops has thus far indicated that the amount of soluble copper in smelter waters used for irrigation is not injurious to plants, but that the detrimental effects popularly ascribed to the presence of mine tailings in irrigation streams, as set forth in Bulletin 53 of the station, are due to sediment. Methods for detecting minute quantities of copper have been worked out by which the presence of 0.01 milligram of copper can be ascertained.

Other principal lines of investigation are sheep breeding, citrus and other fruit work, intensive agriculture, range studies, miscellaneous studies on plant diseases, and analytical work. The breeding experiments with Tunis and range sheep are progressing very favorably toward the creation of a hardy cross-bred animal, resistant to the botfly, producing excellent mutton with a fair yield

of coarse wool, and breeding to advantage under valley conditions in the Southwest. The object of this work is to secure two types of sheep, one for the ranges and the other for the valleys. Dry-farming investigations were inaugurated in Sulphur Springs Valley in January, 1909, under an endowment granted by the El Paso and Southwestern Railway Company. In the northeastern part of the Territory the same kind of work, but carried on with other funds, is being taken up.

The cooperative work in which the station is engaged is limited to investigations relating to the culture of the date palm and to the maintenance and improvement of the range, carried on jointly with the Bureau of Plant Industry of this Department. Extension work in charge of the station is entirely in the nature of farmers' institutes and short courses of study.

In March, 1909, the territorial legislature appropriated for the ensuing two years \$4,500 for the Tempe and Yuma date orchards, \$2,500 for farmers' institutes, \$3,100 for the printing of publications, and \$3,000 for dry farming investigations, making a total of \$13,100.

The following publications were received from this station during the year: Bulletins 57, Timely hints for farmers; and 58, Citrus fruits in the arid Southwest; and the Annual Report for 1908.

The income of the station during the past fiscal year was as follows:

United States appropriation, Hatch Act-----	\$15,000.00
United States appropriation, Adams Act-----	11,000.00
Territorial appropriation, including balance from previous year -----	14,433.84
Southern Pacific and El Paso and Southwestern railroads-----	3,410.47
Farm products and live stock-----	2,806.21
University apportionment -----	400.00
Total -----	47,050.52

A report of the receipts and expenditures for the United States funds has been rendered in accordance with the schedules prescribed by this Department and has been approved.

The Arizona Station is making the most of its opportunities and funds, and is showing good progress in both practical and scientific lines. Its work and its earnest efforts for the agriculture of the Territory find much appreciation, and deserve commendation.

ARKANSAS.

Arkansas Agricultural Experiment Station, Fayetteville.

Department of the University of Arkansas.

C. F. ADAMS, B. Agr., A. M., M. D., *Director*.

The principal changes in the organization of the Arkansas Station during the past fiscal year were brought about by the resignation of W. G. Vincenheller as director, on November 1, and of R. R. Din-

widdie as pathologist and bacteriologist, at the close of the year. C. F. Adams, the entomologist, who had been acting director, was elected to the directorship at the close of the year. The newly appointed agronomist, Martin Nelson, took up his work at the station in October. A differentiation of the college and station has been made, and the State has provided more definitely for extension and farmers' institute work.

Work on the Adams fund projects outlined in previous reports, excepting the one relating to anthrax and anthrax vaccines which was completed last year, was carried forward and generally satisfactory progress was made. The study of the cattle tick with reference to its life history and its relation to the germ of Texas fever has been sufficiently pursued to observe to a considerable degree the route followed by the fever germ in passing from the adult to the young tick. Data in connection with the investigations on the loss of soil fertility in fruit growing and on the toxicity of cotton-seed meal are increasing. The results thus far secured in the apple-twig blight project point to a possible relation between the amount of starch in twigs and the blight. In the hog-cholera project, data with reference to the age of the bacilli as related to their virulence, duration, and means of infection, etc., are accumulating, and the use of serum from hyperimmunized cattle as a curative and preventive of Texas fever is receiving continued attention.

The work carried on by the station with other funds includes soil, fertilizer, rotation, and culture tests with different crops, plant breeding with wheat, oats, barley, rice, and corn, tile draining, cooperative orchard spraying, and forage-crop investigations. The results of the tile-drainage tests show the benefits of tile at certain depths and distances, and the experiments on the effectiveness of sprays have led to the determination of the minimum strength of Bordeaux mixture and arsenate of lead and of the proper strength of boiled and self-boiled sulphur and lime solutions.

The department of entomology studied certain details in the life history of the San José scale with reference to summer treatment and made observations on plant lice to determine their relation to blight and other diseases. A bulletin of information on the San José scale in Arkansas was published during the year. The entomologist acted as state inspector, the expenses being paid by the nurserymen.

The veterinarian of the station devoted much of his time to co-operation with the Bureau of Animal Industry in the eradication of the cattle tick and in examining diseases about the State.

In animal husbandry the department of pathology and bacteriology continued the experiments with wide and narrow rations for pigs, and found that better results than from the exclusive use of corn

are obtained by alternating corn with blood-meal, tankage, and bran. One pound of cotton-seed meal fed in a ration for brood sows remained without fatal results. A bulletin published during the year gives an account of feeding experiments with pigs and compares the capability of the lard and bacon breeds in utilizing wild and narrow rations.

The horticultural department continued experiments with chemicals for the destruction of injurious sprouts, investigated the effectiveness of different substances for spraying, tested methods of cultivating strawberries, conducted experiments with potatoes, including spraying, fertilizers, and cultural methods, and made a study of diseases of tomatoes and apples.

The agronomist has started work on the physical character of the cotton plant, especially the fruiting portion, in relation to the yield and quality, the methods of seeding and cultivating forage crops, and the inoculation of the soil for clovers and alfalfa. Rice experiments will be carried on at Lonoke, and will include studies of plant improvement by selection, varieties, fertilizers, rotations, drainage, and conditions favoring blight. The field-crop work will be conducted at Fayetteville and at the six substations. At each of five substations 20 acres are devoted to field experiments and at Lonoke 190 acres. Four of the substations were opened last year.

The dairy department has made a comparison of corn silage and clover with alfalfa hay, and alfalfa meal and bran as feeds for dairy cows. In butter making the moisture content of butter was studied, and an experiment was made with sweet pasteurized cream with a culture added versus the same kind of cream churned immediately after separation. That department of the station was practically self-sustaining during the year.

Cooperative work with this Department was carried on as in the previous year and consisted of studies on hog cholera, the Texas cattle tick and its eradication, and variety tests of Hungarian apples. Cooperative work was also conducted with farmers of the State and was limited mainly to the growing of crops.

Under extension work the members of the station staff are mostly engaged in institute work as far as their time permits. Some of the departments did inspection work in connection with tick eradication, outbreaks of glanders and hog cholera, fertilizer and feeding stuffs control, and nursery inspection.

The following publications were received from the station during the past year: Bulletins 101, Notes on the cattle tick and tick fever of cattle. The tick eradication in Arkansas in 1907; 102, The San José scale in Arkansas; and 103, The deposition of fat and lean in hogs; and the Annual Report for 1908.

The income of the station during the past fiscal year was as follows:

United States appropriation, Hatch Act-----	\$15, 000. 00
United States appropriation, Adams Act-----	11, 000. 00
State appropriation, including balance from previous year -----	14, 566. 64
Farm products, including balance from previous year--	3, 200. 30
Dairy sales, including balance from previous year-----	9, 137. 60
Total -----	52, 904. 54

A report of the receipts and expenditures for the United States funds has been rendered in accordance with the schedules prescribed by this Department and has been approved.

With the solution of many of the problems regarding its organization, the Arkansas Station is ready to proceed with these various lines of work, and the results secured will no doubt be of assistance and value to the agricultural progress of the State.

CALIFORNIA.

Agricultural Experiment Station of the University of California, Berkeley.

E. J. WICKSON, A. M., *Director.*

As in previous years, the work of the California Station included a large number of different lines as called for by the varied agricultural interests of the State and provided for by special state appropriations. These special appropriations aggregate a large sum and include for the biennial period beginning July 1, 1909, \$130,000 for buildings and equipment at the university farm at Davis, \$88,500 for the operating expenses of the farm, \$20,000 for farmers' institutes, \$15,000 for viticultural investigations, \$12,000 for cereal investigations, and \$40,000 for the southern California pathological station. The last legislature increased the rate of taxation for the benefit of the university to 3 cents upon every \$100 assessed valuation, making the income for the current year about \$600,000.

F. T. Bioletti was reappointed on the station staff during the year and viticultural investigations were resumed. A number of assistants were added to the station staff, including W. T. Horne, assistant plant pathologist; and J. E. Coit, assistant pomologist. Soil bacteriological investigations were extended, with C. B. Lipman as assistant in charge.

The school of agriculture on the university farm at Davis opened in January, 1909. Various divisions of the college of agriculture and agricultural experiment station are using portions of the farm for experimental purposes and to grow feed for stock. The divisions of horticulture and viticulture have 50 acres planted or to be planted to trees and vines; the division of animal industry has 80 acres seeded to alfalfa and 20 acres more under preparation, also several acres in

maize and stock beets. Under a special state appropriation, cereal investigations are conducted upon about 50 acres. The United States Department of Agriculture is conducting irrigation investigations upon 30 acres in methods of applying water. On several smaller areas eucalyptus trees are planted, variety tests of maize are under way, and Egyptian corn and other summer crops grown. The larger part of the farm is in hay and grain and is used experimentally as the needs require. The Davis farm contains 780 acres of land, a large part of which is well suited to experimental work.

The station carried on work on a large number of projects supported wholly or in part by the Adams fund. Some new projects were undertaken during the year and some of the older projects were completed or discontinued. Investigations on the vitality and reproductive power of trees were completed and reported upon. The study of ornamental and economic plants in the Santa Barbara district was completed and the results are ready for publication. The investigations on the life history of the Argentine ant were practically completed during the year and a report on the work is in course of preparation. Investigations on the communicability of California vine disease were abandoned. Experiments with ditch linings, one report on which has already been published, were continued with other funds. Studies of the effect of arsenical poisons on insects were discontinued, but a report on the subject has been prepared. The nutrition experiments begun in cooperation with this Office have been discontinued.

Work on the following projects was continued: Relation of marly soils and of lime to chlorosis of citrus fruits; tolerance of plants for alkali in soils; California peach blight; pear blight; artificial immunization of cattle against tuberculosis;^a metabolism in poultry, and availability of highly nitrogenous feeds; influence of environment on gluten content of grains; and red and yellow scales of citrus trees. At the close of the year several other projects growing out of previous work of the station were proposed. These include bacteria in soils under arid conditions; the nature of physiological plant diseases, like gum disease of citrus trees; causes of sterility of almond trees; and nature and origin of walnut-oak hybrids.

In addition to the Adams fund projects, investigations were made on a variety of problems relating to the chemical, physical, and bacteriological properties of soils as related to productiveness; various diseases of plants, particularly of tomatoes, celery, onions, citrus fruits, apples, peaches, apricots, pears, grapes, olives, nuts, and sugar beets; improvement of wheat, alfalfa, and beans; crop rotations; tuberculosis, and diseases of poultry and other animals; insects

^a See California Sta. Bul. 199.

injurious to crops and their remedies; the relative value of different ditch linings and other irrigation problems; tests of eucalyptus and other forestry problems; and fertilizers and culture for citrus fruits. Extensive plantings of type varieties of various orchard fruits were made at Davis. Inspection of foods, feeding stuffs, and fertilizers was carried on as usual.

Agricultural and horticultural demonstration trains have been operated, manned by a corps of lecturers and demonstrators from the university and station staff. The trains met with an enthusiastic reception, the lecture cars frequently proving inadequate to accommodate those in attendance.

The following publications of the station were received during the year: Bulletins 195, The California grape root-worm; 196, Eucalyptus in California; 197, Grape culture in California.—Improved methods of wine making.—Yeasts from California grapes; 198, The grape leaf-hopper; 199, Bovine tuberculosis; 200, Gum disease of citrus trees in California; and 201, Commercial fertilizers; and Circulars 35, Southern California pathological laboratory and citrus experiment station; 38, The Argentine ant in California; and 39, Instruction in practical agriculture at the university farm, Davis, Cal.

The income of the station during the past fiscal year was as follows:

United States appropriation, Hatch Act.....	\$15, 000. 00
United States appropriation, Adams Act.....	11, 000. 00
State appropriation	99, 067. 90
Fees, including balance from previous year.....	19, 200. 48
Farm products, including balance from previous year..	28, 853. 24
Miscellaneous.....	37, 777. 24
Total.....	210, 898. 86

A report of the receipts and expenditures for the United States funds has been rendered in accordance with the schedules prescribed by this Department and has been approved.

The work of the California Station was developed in many important lines during the year. It was greatly strengthened by added facilities offered by the farm at Davis, and is now being largely focused around three centers, Berkeley, Davis, and Whittier, in southern California.

COLORADO.

Agricultural Experiment Station, Fort Collins.

Department of the State Agricultural College of Colorado.

L. G. CARPENTER, M. S., *Director.*

The work of this station during the year was along the same general lines as in previous years, but a number of changes in personnel and some improvement in equipment were made. Wendell Paddock, hor-



FIG. 1.—NEW IRRIGATION ENGINEERING BUILDING, COLORADO COLLEGE AND STATION.
Contains office of director of the station.



FIG. 2.—HIGHMOOR FARM BUILDINGS AT MONMOUTH, ME.
Purchased by the State for the use of the Maine Station.

ticulturist, resigned to become professor of horticulture in Ohio State University, and B. O. Longyear, botanist, was made also acting horticulturist. A successor to W. L. Carlyle, animal husbandman, was not chosen during the year, but the work in horse breeding, in cooperation with the Bureau of Animal Industry of this Department, to which he had given special attention, was carried on by J. O. Williams, the department representative, pending the reorganization of the animal husbandry department of the station. Fritz Knorr, assistant agronomist, resigned to go into private business.

Agronomy, with Alvin Keyser in charge, bacteriology, with W. G. Sackett in charge, and animal husbandry, were organized as independent departments of the station during the year. Since the close of the year, E. R. Bennett, formerly in charge of potato investigations, has been made professor of horticulture in the college. A poultryman, W. E. Vaplon, was added to the station staff. C. A. Lory, professor of physics and electrical engineering in the college, was made president of the college, and A. M. Hawley was succeeded by L. M. Taylor as secretary of the state board of agriculture (the governing board of the college and station), and disbursing officer of the college and the station.

The federal funds were supplemented by a state appropriation of \$53,000 for the biennial period ending December 1, 1910, including \$8,000 for investigations in plant industry, \$10,000 for horticultural investigations, \$10,000 for investigations in animal husbandry, \$5,000 for horse breeding, \$5,000 for poultry investigations, \$10,000 for potato investigations, and \$5,000 for investigations in farm mechanics. The last legislature also passed an act establishing a substation at Cheyenne Wells. A new building (Pl. II, fig. 1) to cost \$40,000 and to be used for instruction in civil and irrigation engineering and for station and farmers' institute work, was nearly completed, and an agronomy building (seed and crop house) was completed during the year. A project system for recording lines of work of station investigation was inaugurated.

Work was done during the year on five Adams fund projects begun in previous years, but no new projects were undertaken. Investigations on the composition and digestibility of hays (especially saltbush) were practically completed and a bulletin on the subject was published.^a The study of the relation of bees to transmission of blight was temporarily suspended. Work on the wheat project was temporarily suspended except for some preliminary investigations bearing upon the development of a spring milling wheat. Studies in connection with the project relating to water of the San Luis Valley in relation to soluble salts (alkali in the soil) gave some

^a Colorado Sta. Bul. 135.

interesting results during the year with reference to accumulation of large amounts of nitrate in the soil and to bacteriological conditions in the soil. Work was continued as in previous years on plant lice,^a alfalfa blight, seepage, and evaporation.

Aside from these Adams fund projects, the station conducted experiments, mainly in continuation of previous work, on a large number of subjects, including irrigation and evaporation; arsenic poisoning of fruit trees; plant diseases; potato and fruit culture, particularly on the western slope of the State; breeding of grains, alfalfa, and cantaloups; investigations on the potato flea beetle, the codling moth, brown mites, and red spiders; spraying for insect pests and plant diseases; methods of making concrete fence posts; and feeding experiments with cattle, sheep, and swine.

Among the more important recent practical results of the work of the station are the discoveries of the cause and efficient means of treating a destructive bacterial disease of alfalfa, the nature and danger of arsenical poisoning of fruit trees, the occurrence of rapid nitrification in certain soils, and the efficiency of one spray as compared with two or more.

The outside work of the station, supported largely by state funds, consists of potato experiments near Greeley and on the western slope; various horticultural investigations on the western slope; experiments mainly with cantaloups and alfalfa at Rockyford; and dry land experiments at Cheyenne Wells.

The last legislature appropriated \$10,000 for farmers' institutes for the biennium ending December 1, 1910, and most of the members of the station staff have taken part in this work. The railroads of the State have cooperated by furnishing special trains. A special series of farmers' institutes was conducted during the year on the plains of eastern Colorado, in cooperation with a representative of this Department.

The following publications were received from this station during the year: Bulletins 131, Arsenical poisoning of fruit trees; 132, Destruction of concrete by alkali; 133, A few orchard plant lice; 134, Orchard plant lice and their remedies; 135, The Australian saltbush (*Atriplex semibaccata*): Its composition and digestibility; 136, Dewberry growing; 137, Some animal diseases; 138, Some bacterial diseases of plants; 139, Pruning mature fruit trees; 140, Strawberry growing in Colorado; 141, Grape growing; 142, Tillage, fertilizers, and shade crops for orchards; 143, Cabbage growing on the irrigated lands of Colorado; and 144, Celery growing in Colorado; Circulars 1, Potato notes; and 2, Hog raising in Colorado; and the Annual Reports for 1907 and 1908.

^a See Colorado Sta. Buls. 133 and 134.

The income of the station during the past fiscal year was as follows:

United States appropriation, Hatch Act.....	\$15, 000. 00
United States appropriation, Adams Act.....	11, 000. 00
State appropriation.....	2, 500. 00
Balance from previous year, state appropriation.....	13, 027. 39
Miscellaneous.....	19, 349. 50
Total.....	60, 876. 89

A report of the receipts and expenditures for the United States funds has been rendered in accordance with the schedules prescribed by this Department and has been approved.

The work of the Colorado Station has been well maintained during the year notwithstanding numerous changes in personnel and organization. That its work is appreciated is shown by the fact that it is well supported by state appropriation. The conditions and agricultural interests of the State are, however, extremely varied, and the station has a very wide field to cover.

CONNECTICUT.

The Connecticut Agricultural Experiment Station, *New Haven.*

E. H. JENKINS, Ph. D., *Director.*

The year was marked by many changes in the station staff. H. R. Stevens resigned as chemist and was succeeded by C. W. Rodman, who also resigned during the year and was succeeded by R. B. Roe. A. F. Hawes, station and state forester, accepted a similar position in Vermont. E. M. East, in charge of plant-breeding work, accepted an assistant professorship at Harvard University. C. E. Shepard was appointed chemist, vice C. A. Brautlecht, resigned, and S. N. Spring and W. O. Filley were appointed forester and assistant forester, respectively. The botanist of the station was detailed to go to Japan for the purpose of securing a fungus parasitic on the gipsy moth, which he was successful in introducing.

The State made an appropriation of \$30,000 for the building and equipment of a fire-proof addition to the station laboratory to provide especially for the accommodation of the chemical work. An appropriation of \$500 was also made for apiary inspection. This work, relating especially to foul brood, was placed in charge of the station entomologist in his capacity as state entomologist.

The work under the Adams fund, as heretofore, was limited to investigations on vegetable proteids and to work in plant breeding. The projects on the vegetable proteids have progressed and preliminary steps were taken to evolve suitable methods for studying the metabolic balance when these proteids are used in feeding experiments, together with fats and carbohydrates. The Carnegie Institu-

tion continued its grant to the station for this research work. Four papers, including a reference to everything that has been done in the examination of the vegetable proteids, a critical review of the work, and an orderly statement of the results were prepared for publication.

The plant breeding investigations included work with the potato, corn, and tobacco. The potato project is nearing completion. It was found that the characters so variable after sexual reproduction were not too complex for analysis, but were merely obscured by the great reaction of the plant to its environment. Ordinary asexual variations were not inherited, but in case of inherited bud variations the change was observed to be due to the loss of a character. From the work on inheritance on seed characters and plant characters in maize, which was in part carried on in cooperation with farmers, interesting results were obtained, but the work of several seasons is required to complete the observations. Cross-bred strains of corn were found to be more vigorous than pure-bred strains owing to the tendency of these to become homozygous in all Mendelian characters.

Progress is also reported in the experimental work supported by the Hatch fund. The entomologist made a study of plant lice, conducted work in combating the gipsy moth which was nearly stamped out in a known infected area, and prepared extensive papers on the Connecticut Orthoptera and Hymenoptera to be published by the state natural history survey.

The department of botany conducted spraying experiments against potato blight and worked on the problem of finding the other resting-spore stage of *Phytophthora*. Disease resistance in melons, peach yellows, tobacco diseases, and white-pine rust were also given attention. The botanist brought home from Japan a fungus which attacks the gipsy moth and which may prove of value in combating this pest. The forester completed and published a forest survey of two counties as the first installment of the complete forest survey of the State. Much work was done in planting the state forest, in improving the forest fire service, and in encouraging planting by private owners of woodland.

The station is cooperating with the Bureau of Plant Industry of this Department in the study of the improvement of tobacco and of the loss by heredity. A few cooperative experiments with farmers were also made in the State. No extension work was undertaken by the station.

During the year the following publications were received by this office: Bulletins 161, Feeds, seeds, and weeds; 162, Forest survey of Litchfield and New Haven counties, Conn.; 163, Agricultural lime: Its sources, composition, and prices, with notes on its action in the soil; and the Annual Report for 1907-8, parts 8, Report on commercial fertilizers, 1908; 9, Food products, 1908; 10, Commercial

feeding stuffs, 1908; and 11, Eighth report of the state entomologist, 1908.

The income of the station during the past fiscal year was as follows:

United States appropriation, Hatch Act.....	\$7, 500. 00
United States appropriation, Adams Act.....	5, 500. 00
State appropriation.....	17, 500. 00
Individuals	5, 895. 88
Fees	8, 970. 02
Farm products.....	205. 13
Miscellaneous.....	740. 63
Total	46, 311. 66

A report of the receipts and expenditures for the United States funds has been rendered in accordance with the schedules prescribed by this Department and has been approved.

The results of the work pursued at the Connecticut State Station are of much scientific interest and of considerable economic value to the agriculture of the State. The station is making good use of the funds at its disposal.

Storrs Agricultural Experiment Station, Storrs.

Department of the Connecticut Agricultural College.

L. A. CLINTON, M. S., *Director*.

The lines of work for the past fiscal year were essentially the same as those previously reported, only one new project having been inaugurated. A greenhouse was added to the equipment for work in plant breeding.

Encouraging progress was made in the Adams fund projects already under way, and as a new project the study of the white diarrhea of chicks was taken up. The object of this new work, which is carried on in cooperation with Dr. L. F. Rettger, of Yale University, is to determine the source of infection, to ascertain the organism producing the disease and its method of propagation, and to discover means of prevention and treatment. The experiments in manufacturing foreign types of cheese carried on in cooperation with the Dairy Division of the Department of Agriculture have been continued with interesting and valuable results, and a bulletin recording in part the data thus far secured was issued near the close of the year.

The sources of *Bacterium lactis acidi* in milk were definitely determined in the year's work, and this result is considered as being of much practical as well as of scientific importance. A bulletin recently published describes the work in detail and points out that the source of the organism is animal secretion and excretion. The mangers of the cows as well as the cows themselves were found to be the most abundant source. In the line of plant breeding, problems of heredity

as exemplified by muskmelons and beans and the technique of the transmission of characters are being studied. The relation of bacteria to the hen's egg was studied by the zoologist, and the conclusions reached with reference to infection and preservation of eggs have recently been published in bulletin form.

With other funds a feeding experiment has been begun with 2 groups of cows to determine the effect of high and low protein rations on the milk production, on the individual animal, and on the progeny, and as far as possible on the possibility of transmitting these effects. During the summer, the horticulturist carried on experiments in the spraying of melons and cucumbers for the control of blight and with beans for the control of anthracnose. Variety testing was also carried on to a considerable extent. A bulletin on the control of the San José scale was issued during the year.

The only extension work in which the station is engaged is the lecture work done in connection with the farmers' institutes throughout the State.

The following publications were received from this station during the fiscal year: Bulletins 52, Poultry culture; 53, Improving dairy conditions; 54, Proprietary and homemade miscible oils for the control of the San José scale; and 55, Infection and preservation of eggs; and the Annual Report for 1907.

The income of the station during the past fiscal year was as follows:

United States appropriation, Hatch Act-----	\$7, 500. 00
United States appropriation, Adams Act-----	5, 500. 00
State appropriation -----	1, 800. 00
Balance from previous year, state appropriation-----	1. 18
Miscellaneous, including balance from previous year---	648. 06
Total -----	15, 449. 24

A report of the receipts and expenditures for the United States funds has been rendered in accordance with the schedules prescribed by this Department and has been approved.

The policy of the Storrs Station in concentrating its efforts along a few important lines is proving valuable in the character of the work done and the importance of the results obtained.

DELAWARE.

The Delaware College Agricultural Experiment Station, *Newark*.

Department of Delaware College.

H. HAYWARD, M. S. Agr., *Director*.

Much progress was made at this station during the year in perfecting organization, improving equipment, and developing lines of work. C. O. Houghton, formerly entomologist of the station, was

transferred entirely to college work, while M. T. Cook, plant pathologist, and Firman Thompson, chemist, were relieved of all college work. H. D. Eggers, a graduate of the University of Pennsylvania, was appointed assistant chemist, and Jacob Taubenhau, a graduate of Cornell University, assistant plant pathologist. C. L. Penny, formerly chemist of the station, but recently professor of chemistry at Pennsylvania State College, returned to the Delaware College at the close of the year as professor of chemistry, succeeding T. R. Wolff, deceased.

A state appropriation of \$10,000 for new farm buildings became available during the year, and the much-needed improvements of this kind have been begun. Progress was also made especially in establishing orchards on the farm, extending the field experimental work, constructing tanks for studying the fertilizer requirements of orchard fruits, improving facilities for veterinary investigations, and in providing better laboratory rooms for the chemist.

The work prosecuted during the year with the funds provided by the Adams Act included a continuation of investigations on functions of tannin in plants, double blossom disease of the genus *Rubus*, anthrax, and glanders. Several new projects were planned which were not actively entered upon during the year. Certain phases of the investigations on tannin and double blossom are approaching completion. In the investigations on anthrax the station cooperated with the Bureau of Animal Industry of this Department.

In addition to the Adams fund projects named, the station conducted variety tests of wheat, corn, oats, soy beans, and cowpeas; and experiments with fertilizers and lime and with crops in a four-year rotation; on the relation of typical corn kernels to chemical composition and vigor of the corn plant; on the stooling habit of different varieties of winter wheat; on various lime-bearing materials and their efficiency in overcoming soil acidity and increasing the yields of field crops; on the effect of different forms of lime on the decomposition of the organic matter of the soil and the consequent liberation of nitrogen; the best date for planting late potatoes in northern Delaware and the effect of various fertilizers on potatoes and tomatoes; the effect of various cover crops on peaches; Bordeaux injury to apples; and rotation systems with potatoes and tomatoes. Experiments on the effect of close breeding on swine have been started.

The extension work of the station was limited entirely to occasional lectures and some farmers' institute work. A very successful "farmers' day" was held at the college and station during the summer of 1909, about 150 persons attending and inspecting the work of the station.

The publications of the station during the year included Bulletins 82, Report on forest conditions in Delaware and a forest policy for the State; 83, Diseases of field crops in Delaware in 1907; 84, Annual report of the director for the fiscal year ending June 30, 1908; and 85, Spraying for brown-rot of the peach, 1908.

The income of the station during the past fiscal year was as follows:

United States appropriation, Hatch Act.....	\$15,000.00
United States appropriation, Adams Act.....	11,000.00
Farm products	1,984.63
Miscellaneous	228.90
Total.....	28,213.53

A report of the receipts and expenditures for the United States funds has been rendered in accordance with the schedules prescribed by this Department and has been approved.

The Delaware Station was greatly strengthened during the year for both scientific and practical work of great importance to the State. This was due to improvement of both farm and laboratory equipment, enlargement of the staff, and clearer differentiation of college and station duties. The equipment of the former with suitable buildings will greatly enlarge the scope and increase the efficiency of the experimental work of the station.

FLORIDA.

Agricultural Experiment Station of Florida, *Gainesville*.

Department of the University of the State of Florida.

P. H. ROLFS, M. S., *Director*.

The Florida Station made further progress during the year in establishing itself in its new location. Greenhouses, stables for the horticultural department, and barns for the agricultural department were constructed and much of the land was put into shape. The station farm is entirely separated from that of the college and has its own animals, pastures, fields, and equipment.

A number of changes occurred on the station staff. H. S. Fawcett, the assistant plant pathologist, was made plant pathologist. A. Dickinson, who succeeded W. Hess as gardener on July 7, resigned October 1. E. P. Green worked as assistant in entomology and Thomas Hamilton as assistant in plant pathology for a number of months during the year. At the close of the fiscal year O. F. Burger commenced work as assistant in plant pathology, B. B. Ezell as assistant in plant physiology, and S. E. Collison as assistant in chemistry. The members of the station staff devote themselves almost exclusively to station work, having but little connection with teach-

ing or other work. The \$40,000 appropriated by the last legislature for a new station building did not become available until some time after the close of the fiscal year, when work on the new structure was begun.

The Adams fund projects of the station were all carried forward during the year. Results obtained in connection with studies of diseases of citrus fruits indicate that the scaly-bark disease is due to a fungus and that the malady is aggravated by the wither-tip fungus which attacks the diseased portions. Means of control were studied in a private orchard. By producing the disease through inoculation it was shown that the scab attacking the fruit and leaves of sour orange, satsumas, and grape fruit is due to a fungus. A bacterium accompanying the gumming of citrus trees was studied as a possible cause of the malady.

In following up the project on parasites of the white fly as a means of control, it was found that 2 species of the insect occur and that one of them (*Aleyrodes nubifera*) is readily attacked by the yellow fungus. Spraying trees with spores of the yellow and red fungus was found effective in destroying the larvæ, and the method has already been taken up commercially (Pl. III, fig. 1). The spores for the sprays were drawn from the laboratory or obtained from affected leaves.

The studies in plant nutrition with reference to physiological diseases, carried on with cassava and citrus fruits, showed that such citrus diseases as die-back, yellow spot, melanose, and frenching are not caused by an organism, but are due to malnutrition. A deep russetting of the orange was found due to fertilizers and especially to those furnishing ammonia.

The pineapple work in connection with the study of soils and fertilizers in relation to plant growth and development was continued, and a report on the results of analysis of the fruit is about ready for printing. No special effect of any particular fertilizer was observed, but different amounts seemed to affect the composition. Steps have been taken to study the effect of fertilizer ingredients on citrus fruits.

The station also has in progress a number of lines of work supported by the Hatch fund. The horticultural department studied and largely worked out the embryology of the mango and also made some studies on the preparation of guava jelly. The botanical department gave attention to the improvement and selection of lettuce and celery for disease resistance, and also conducted breeding work with the velvet bean to produce a bush form. Other lines of plant improvement carried on by the station are cotton breeding for length of staple, silkiness, and nap; breeding a type of corn adapted to the State; introducing and acclimatizing the Lyon bean brought

from the Philippines; and field experiments with sorghums and other grasses and forage crops (Pl. III, fig. 2). The animal husbandman devoted his attention largely to comparing Florida-grown with purchased feeds for milch cows and steers and to the improvement of the native cattle.

The station is carrying on cooperative work with farmers in connection with various problems, with the Bureau of Plant Industry of this Department in testing cowpeas and other leguminous crops and grasses, and with the Bureau of Chemistry in studying the sugar content of sugar corn in Florida. The director, as superintendent of farmers' institutes, spoke at nearly all of the 55 institutes held during the year, while other members of the station staff addressed comparatively few of these gatherings.

The publications received from the station during the year were as follows: Bulletins, 94, Fungus diseases of scale insects and white fly; 95, Dwarf Essex rape for winter forage; 96, Steer feeding; 97, White fly studies in 1908; 98, Scaly bark of citrus; and the Annual Report for 1908.

The income of the station for the past fiscal year was as follows:

United States appropriation, Hatch Act	\$15,000.00
United States appropriation, Adams Act.....	11,000.00
Balance from incidental fund.....	16.50
Farm products, including fees.....	913.91
Total	26,930.41

A report for the receipts and expenditures for the United States funds has been rendered in accordance with the schedules prescribed by this Department and has been approved.

The Florida Station in general is well organized and equipped and shows the effect of efficient management, left mainly to the station experts. It has a loyal following, and since it removed to the new location its mailing list has grown from 2,500 to 11,000 names.

GEORGIA.

Georgia Experiment Station, *Experiment.*^a

Department of Georgia State College of Agriculture and Mechanic Arts.

M. V. CALVIN, *Director.*

The lines of work at the Georgia Station were not materially changed during the year. The only change in the station staff resulted from the resignation of the dairyman and animal pathologist, C. L. Willoughby.

Most of the Adams fund projects were continued, but one or two were discontinued or held in abeyance through lack of material. The

^a Telegraph, freight, and express address, *Griffin.*

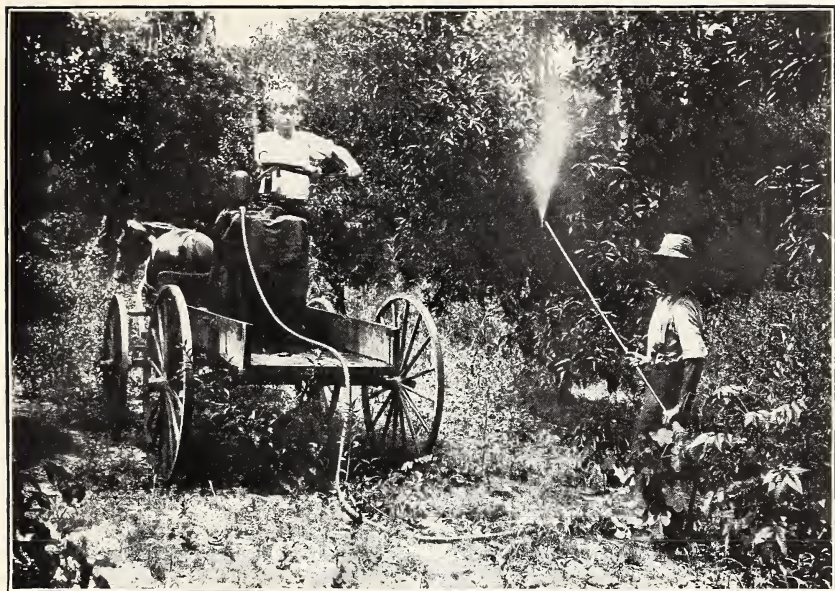


FIG. 1.—SPRAYING A WHITE-FLY INFESTED ORANGE GROVE WITH SPORES OF A FUNGUS INJURIOUS TO THE FLY, FLORIDA STATION.



FIG. 2.—JAPANESE SUGAR CANE AT THE FLORIDA STATION.
One of the best forage crops for the State.

botanical department continued the studies on cotton anthracnose and the investigations on Mendelian and De Vriesian laws in application to the cotton plant. Attention was mainly given to determining how the organism causing anthracnose lives over winter, and to the growing of cotton plants for the selection and breeding of resistant strains or varieties. The particular features to which resistance may be due were also studied.

The bacteriological department took up the study of the effect of stable manure on the bacterial flora of soils. The number of bacteria in treated and untreated soils was determined, the changes in the predominance of species noted, and the ability of the treated and untreated soils to nitrify cotton-seed meal and sulphate of ammonia was compared.

Work on the Texas fever project was begun in December. The cows under observation had had Texas fever and the work was undertaken merely to determine the effect of the ticks on the blood and the general condition of the animal due to their presence.

The horticulturist took up the project on the application of Mendel's law in hybridizing black and white varieties of Muscadine grape. The work on the wilt of the Japanese plum, which was under way, was again taken up.

The inquiry into a new feeding standard for cattle by means of the nitrogen balance was repeated with eight calves. This work consisted of frequent digestion experiments and of tests of the metabolized nitrogen.

Under the Hatch fund, the animal husbandman conducted feeding experiments with milch cows for the purpose of comparing a ration made up of cotton-seed meal, cotton-seed hulls, and oat straw with one consisting of corn silage, cotton-seed meal, and oat straw. The results of this test were not very decisive, but taking into consideration the cost of the rations and the health of the cows, the use of silage was found preferable. A test was also made of silage as a summer feed, and a comparison of rations with and without corn meal. At the present high prices, corn meal was not found to be an economical summer feed. In a feeding experiment with hogs, special attention was given to testing the value of soy beans in the ration.

The dairy department studied the conditions required for making fermented beverages with starters furnished by the manufacturers. A study of buttermilk showed that the buttermilk made by churning whole milk contained much more fat than that obtained from churning cream. It was concluded that this difference accounted for the difference in palatability.

The horticultural department recorded the time of blossoming of eighty or more varieties of peaches and also made records of various other kinds of fruit. Culture, fertilizer, and variety tests were con-

ducted with cabbage, tomatoes, strawberries, melons, and sweet potatoes.

Field experiments were carried on along former lines. Culture, fertilizer, and variety tests were made with cotton, corn, wheat, and oats. The department of agronomy has about 60 acres at its disposal for experimental purposes.

In January, 1909, a dairy extension department was organized, the dairy division of the Bureau of Animal Industry, of this Department, cooperating with the station in this work. Observations were made on the milk production of different cows and other dairy matters.

The following publications were received from this station during the year: Bulletins 80, Cooperative dairy investigations; 81, The effect of carbonates upon nitrification; 82, Sugar corn and tomatoes; and 83, The Mendelian and De Vriesian laws applied to cotton breeding; and the Annual Report for 1908.

The income of the station during the past fiscal year was as follows:

United States appropriation, Hatch Act-----	\$15,000.00
United States appropriation, Adams Act-----	11,000.00
State appropriation-----	710.10
Farm products, including live stock-----	4,612.47
Balance from previous year, farm products-----	1,341.09
Total-----	32,663.66

A report of the receipts and expenditures for the United States funds has been rendered in accordance with the schedules prescribed by this Department and has been approved.

The Georgia Station is conducted in an orderly way and is following a number of lines of work of both practical and theoretical importance.

GUAM.

Guam Agricultural Experiment Station.

Under the supervision of A. C. True, Director, Office of Experiment Stations,
United States Department of Agriculture.

JOHN B. THOMPSON, B. S., *Special Agent in Charge.*

The work of the Guam Station during 1909 was largely that of a pioneer nature. Toward the end of the fiscal year John B. Thompson, a graduate of the Kansas Agricultural College, who had had several years' experience with the Bureau of Agriculture in the Philippine Islands, was placed in charge of the station and made its temporary disbursing officer.

Under the direction of H. L. V. Costenoble a tract of land containing about 27 acres was leased and fenced, and considerable effort made toward bringing it into cultivation. This land had formerly been cultivated but had not been so used for several years and had reverted

to almost a tropical jungle. A considerable portion of the time during the fiscal year was spent in clearing this land and getting it again into cultivation.

The experimental work thus far begun has consisted largely of the introduction of forage plants. Guinea grass and Bermuda grass have been introduced through the Hawaii Experiment Station, and the plants appear to do well, considering the exceptionally dry season. Three varieties of sorghum were tested for their adaptability for forage, and they are reported as having grown exceedingly well and produced an excellent crop. Some attempts have been made to carry on experiments in restoring the fertility of the soil, and numerous leguminous plants have been introduced to grow in rotations between the rows of sorghum.

A considerable number of pineapple plants, several varieties of bananas, and a number of avocados from Hawaii were planted and are reported as growing vigorously. Other economic plants have been introduced from Java and elsewhere, and as rapidly as supplies are on hand they will be distributed to the people for cultivation. Tests are being made of the different varieties of corn, comparing them with the form generally grown in Guam. Breeding experiments have been begun with corn and other plants, and attempts are being made to introduce and test varieties of vegetables and other plants. A coconut disease which threatened that industry has been found to be due to a species of mealy bug, and an introduction of ladybirds from Hawaii has been successfully made and it is hoped that they will reduce the number of destructive insects.

The income of the station during the past fiscal year was as follows:

United States appropriation-----	\$5,000.00
Farm products-----	6.00
Total-----	5,006.00

The work of the Guam Station for some time will consist principally of demonstrations in methods of agriculture and the introduction and testing of field and horticultural crops. From reports that have been received the people of the island seem to be taking an active interest in the work thus far conducted, and it is hoped that through this agency it will be possible to restore and develop the agriculture of this island.

HAWAII.

Hawaii Agricultural Experiment Station, *Honolulu*.

Under the supervision of A. C. True, Director, Office of Experiment Stations,
United States Department of Agriculture.

E. V. WILCOX, Ph. D., *Special Agent in Charge*.

A few changes were made in the staff of the Hawaii Station during the fiscal year. Walter P. Kelley, of the Indiana Experiment Sta-

tion, was appointed chemist; D. L. Van Dine, for six years entomologist of the station, was transferred to the Bureau of Entomology of this Department; D. T. Fullaway, formerly assistant entomologist, was promoted to the head of that department; and Valentine Holt was appointed assistant in plant propagation.

The work of the different departments made marked progress during the year. In the department of agronomy particular attention was given to forage crops, rice, and cotton. The experiments with forage plants attracted the attention of ranchmen and planters, who are learning the economic value of producing forage, especially from leguminous plants grown in crop rotations. The cultural and fertilizer work with rice is giving valuable results, and some of the better varieties of rice introduced by the station have been widely planted with gratifying results. Methods of fertilizing the rice crop were devised at the station that more than doubled the yield of rice on ordinary rice lands. The breeding experiments with rice are being continued and some very promising varieties were secured. The work with cotton attracted much attention. The station has a number of varieties of Upland, Chinese, Egyptian, Sea Island, and Caravonica cottons under observation, and a number of promising strains of Sea Island and Caravonica have been developed. In propagating cotton it has been found possible to grow the plants, particularly Sea Island and Caravonica, as perennials, and to propagate them from cuttings, by grafting and budding. This is of especial value for the rapid production of desirable strains where the elimination of cross fertilization is desired. By growing the plants as perennials and pruning at the proper seasons it has been found possible to control the time of maturity of the bolls so as not to interfere with the activity of plantations during the cane-grinding season.

The horticulturist's investigations on the shipment of fruits resulted in a large and growing business in the shipping of fresh fruits, particularly pineapples. The studies were continued on the methods of propagation of tropical fruits, such as citrus trees, avocados, mangoes, papayas, and other fruits, and some improvements were made in methods of propagation, especially of the mango. Studies are being made in the care of orchards, and demonstration experiments were conducted on the eradication of scale insects and mealy bugs by fumigation with hydrocyanic-acid gas.

An important line of work taken up by the chemist was a study of soils, especially on the island of Oahu, where pineapple plantings are being rapidly extended. The soils where pineapples are planted are usually of two types—red and black, the former being better adapted to the crop. The black soils were found to contain a high percentage of manganese, and studies show that this accumulates on the

roots and root hairs of the plants, interfering with their absorptive powers.

The entomological work consisted principally of a study of cotton insects, together with methods for their control. Cooperative experiments are being carried on in the introduction of parasites of the algaroba bean weevil, plant lice, etc.

A number of miscellaneous investigations were carried on during the year, and as a result of cooperative experiments a method of grinding the algaroba bean was devised by which a large proportion of the feeding value of the beans is saved. The rubber investigations received considerable attention, and tapping experiments with 500 trees were conducted to determine the commercial aspects of this industry.

The publications of the Hawaii Station during the past year were the Annual Report for 1908; Bulletin 18, Insects of Cotton in Hawaii; and Press Bulletins 21, Fruit Marketing Investigations in 1907; 22, Pineapple Shipping Experiments in 1908; 23, The Influence of Manganese on the Growth of Pineapples; and 24, A Preliminary Report on Cotton Experiments.

The revenues of the station for the fiscal year ended June 30, 1909, were as follows:

United States appropriation.....	\$26,000.00
Farm products.....	605.89
Total	26,605.89

The work of the Hawaii Station in diversifying agriculture and developing new industries is being steadily pushed, and the results obtained show evidence of the development of some important industries in the near future.

Hawaiian Sugar Planters' Experiment Station, Honolulu.

C. F. ECKART, M. S., *Director of Division of Agriculture and Chemistry.*

The work of the division of agriculture and chemistry, as in previous years, was largely devoted to the propagation and selection of varieties of seedling canes. Of over 300 of these new varieties tested on a small scale, those designated as Hawaii Nos. 20, 24, 70, 224, 227, 270, and 309 proved of conspicuous merit. At the station a number of inferior varieties were weeded out, thus reducing the number of promising sorts to 136 out of 5,000 originally obtained. During the year experiments dealing with fertilizers and with the effect of "stripping" on canes were conducted on plantations co-operating with the station. Eighty-three seedling canes of known parentage, grown to maturity, showed no evidence of merit and all were destroyed.

The division of entomology continued its routine work of breeding and distributing parasites as a means of combating insect pests and of inspecting the plantations periodically. Efforts are being put forth to introduce a tachinid fly from Larat, which destroys cane-borer larvæ. Some difficulty has been encountered in this undertaking, as the scheme for forwarding material to a half way station at Hongkong was not successful.

The division of plant pathology, in addition to the inspection of all plantations, devoted its attention to a diseased forest area in Maui and to diseases of pineapples. The forest disease was not found due to a fungus, but the cause was attributed to chemical changes in the soil, probably under the influence of bacteria. The officers of this division now act as inspectors of imported plant material in conjunction with the territorial officials.

The following bulletins of the station were received during the year: Division of agriculture and chemistry, Bulletins 27, Total solids in mill products by the refractometer; 28, Fermentation of Hawaiian molasses; 29, The action of soluble fertilizers on cane soils; division of pathology and physiology, Bulletin 9, Bacterial flora of Hawaiian sugars.

This station receives no direct aid from the federal appropriations.

C. F. Eckart, director of the division of agriculture and chemistry, returned from a leave of absence in February. R. C. L. Perkins, director of the division of entomology, and Lewton-Brain, director of the division of pathology and physiology, were absent on leave in Europe. F. T. Dillingham, assistant chemist, resigned during the year to accept the position of professor of chemistry at the college of Hawaii.

IDAHO.

Agricultural Experiment Station of the University of Idaho, *Moscow*.

Department of the University of Idaho.

W. L. CARLYLE, M. S., *Director*.

A number of very important changes were made at this station during the year. The director, H. T. French, resigned to take effect June 1, 1909, and E. E. Elliott, formerly of the Washington college and station, was made acting director. Since the close of the year covered by this report, W. H. Wicks has been appointed horticulturist, vice J. R. Shinn, and L. F. Childers, agronomist, vice R. E. Hyslop. John F. Nicholson, formerly connected with the Oklahoma College and Station, has been appointed bacteriologist, H. P. Fishburn and C. W. Colver assistant chemists, and G. E. Trevert assistant in dairying.

A well-equipped dairy laboratory was established during the year and a greenhouse and an outdoor plant breeding house were built.

The last legislature appropriated \$8,000 for substations, and such stations are now established at Caldwell, Gooding, and Clagstone, and it is proposed to establish a fourth at Idaho Falls. The legislature also appropriated \$4,000 for new barns, \$2,000 for improving the herd, and \$2,500 for laboratory equipment.

The following Adams fund projects were actively prosecuted during the year: Causes of deterioration and improvement of wheat, duty of water (at Caldwell), and apple breeding, and considerable progress was made in the investigation of these subjects. Investigations on the utilization of orchard by-products were suspended for a large part of the year. A beginning was made upon a new project, viz, the relation of salt and acidity to the keeping quality of butter.

In addition to these Adams fund investigations the station has carried on important work on the improvement of varieties and methods of culture of cereals and strawberries; the farmer's vegetable garden and methods of culture of various truck crops, particularly tomatoes, onions (in orchards), and cantaloups; fertility and rotation tests with wheat, oats, and potatoes; development of a shorthorn dairy herd; the determination of moisture in butter and the shrinkage of butter in shipping; the chemical composition of fruits, feeding stuffs, and soils; comparison of liquid and dust sprays and different strengths of lime-sulphur wash for apple scale; selection of corn for early maturity; thinning and girdling apples; and control of cabbage insects. Extensive irrigation experiments were carried on as in previous years at Caldwell in cooperation with the irrigation investigations of this Office. Cooperative experiments with farmers in the improvement of wheat were also made.

Station men participated to some extent in farmers' institutes and extension work during the year, and in February, 1909, a demonstration train similar to that sent out in northern Idaho the previous summer was run for about a month with great success through southern Idaho.

The following publications were received from the station during the year: Bulletins 60, Conditions affecting the production of denatured alcohol in the Northwest; 61, Spraying experiments for 1907; 62, Dry farming in Idaho; 63, Babcock test for butter fat; 64, Planting apple orchards in Idaho; and 65, Alaska wheat investigation; and the Annual Report for 1907.

The income of the station during the past fiscal year was as follows:

United States appropriation, Hatch Act-----	\$15, 000. 00
United States appropriation, Adams Act-----	11, 000. 00
Farm products -----	2, 052. 17
Total-----	<u>28, 052. 17</u>

A report of the receipts and expenditures for the United States funds has been rendered in accordance with the schedules prescribed by this Department and has been approved.

While, as the above report shows, the Idaho Station has done some creditable work and made a number of important improvements during the past year, the conditions at the station for a large part of the time have not been such as could be expected to develop its highest usefulness and efficiency.

The director of the station was forced to resign near the close of the year, after several years of faithful and conscientious service which in view of the somewhat adverse conditions had been creditable to himself and to the institution. This act of the board and the events leading up to it were resented by several members of the staff, who considered it unjust and an unwarranted blow at the stability of station positions. The spirit of the staff was broken, and two of its members were led to action which resulted in their removal during the fall. Although the change in director was contemplated for some time a successor was not chosen for nearly nine months, and in the meantime the station affairs were left to an acting director.

No station can escape the effects of such a course. Its work was interrupted and seriously interfered with, the confidence of the staff was shaken, and the station was given an undesirable reputation. It is sometimes necessary to make changes in the personnel of an experiment station, but when this is done it should be done in a manner that will leave no question that the action is prompted by the best interests of the institution, and that the position of its personnel as workers in a scientific institution is fully recognized.

The Department's disapproval of the course pursued was clearly set forth, and the course of action necessary to restore the station to a proper working basis was pointed out. Pending the settlement of affairs the payment of the federal funds was withheld from the institution.

The station has now been reorganized, with a new director and several new members on its staff, and it is hoped that stable conditions have been established which will enable it to continue its work effectively, and will guard it against future attack or interference.

ILLINOIS.

Agricultural Experiment Station of the University of Illinois, *Urbana*.

Department of the University of Illinois.

EUGENE DAVENPORT, M. Agr., *Director*.

The large amount of work of a scientific and practical nature conducted by the Illinois Station is facilitated and well supported by

an extensive equipment and generous resources. The resignations during the year affected the membership of the staff but little. J. T. Barrett resigned as assistant in botany and C. E. Lee, assistant chief in dairy manufactures in the station, accepted a position as assistant in dairy husbandry in the University of Wisconsin. The following appointments of assistants were made: D. L. James and L. R. Lang, dairy husbandry; C. E. Durst, olericulture; H. W. Stewart, soil survey; E. W. Bailey, plant breeding; A. H. Nehrling, floriculture; and W. A. Ruth, horticultural chemistry. The experimental greenhouse of the department of floriculture was enlarged by an addition, 28 feet by 222 feet, which exactly doubled its capacity. No increase in appropriations was granted the station by the legislature except that the soil funds were raised from \$25,000 to \$60,000 a year. This increase is to be devoted to an extension of the soil survey and the publication of the results of investigation.

Progress is reported in all of the Adams fund projects under way. Studies of heredity by the statistical method are made from herd books for animals and from data on corn and other plant breeding at the station. Sufficient data, especially on correlation of characters in corn, have accumulated to warrant their publication, and a bulletin is under preparation. An extensive study of heredity in milk production developed a good case of false correlation, which is about to be presented by means of an article to appear in an important scientific journal. The investigation of the effects of inbreeding has made headway, but the results are not ready for discussion at present.

Plant-breeding studies were conducted with apples, peaches, strawberries, and sweet peas. The station has 700 trees from apple-bud selections made in the spring of 1908 and 400 trees grown from selections in 1909. Of apple pollinations, $12\frac{1}{2}$ per cent, and of peach pollinations, 22.36 per cent, matured fruit. The most significant result in the work with the strawberry was vigor of growth and remarkable productiveness in many of the seedlings as compared with the parent plants. Of sweet-pea pollinations 18.7 per cent were successful. The seedlings of all these different plants are under observation for the purpose of determining their value. In connection with the project on the chemical and physiological changes resulting from varying rations, 20 steers were fed for thirty-four weeks, and the data secured are being prepared for publication. A bulletin of progress has been issued on the investigation of Bordeaux mixture in its relation to orchard trees and principally to the foliage. The use of impure or improper materials, carelessness in making the mixtures, and improper or ineffective application were observed as the principal sources of injury. It was further found that

the injuries apparently not under control are associated with unfortunate weather conditions, and particularly with the action of rain and dew.

The investigations carried on with the Hatch and other funds are numerous and extensive. The work on soils, including fertility studies, soil analysis, soil surveys, and similar work, was continued and is being enlarged. The extension of the soil survey covered the resurveying of three counties and the completion of four counties, which practically finishes the work in twenty-eight counties of the State. The object of the experiments in soil fertility is the establishment of a permanent system of agriculture on the different types of Illinois land. The results give increased evidence that in connection with profitable farming operations the actual fertility of the land may be improved, provided the fertilizers purchased are restricted to phosphorus on certain lands of the State and to potassium on others, with an occasional application of lime to correct acidity. It is reported that land is coming to be valued in the State according to its location, type, and fertility, as determined by the soil survey. Analyses confirmed previous results by showing that large sections of the State are exceedingly deficient in potassium and that the typical prairie soils are principally deficient in phosphorus.

The dairy department has pursued investigations on the composition and quality of butter, which involved the handling of 10,000 pounds of butter for storage, 1,000 chemical analyses of cream, and 14,000 fat determinations. The object of the work is the adoption of more profitable methods by the creamery industry. This department is also managing a 20-acre dairy farm with a view to determining the highest possible production of milk per acre from feed raised upon the 20 acres. The past year each 1.43 acres maintained a cow. The feed consisted largely of corn silage and alfalfa, and the average production per acre was 3,660 pounds of milk and 141 pounds of butter. Strict accounts are kept in order to determine the possibility of successful dairying on small farms.

The department of horticulture had considerable work in progress throughout the State with fertilizers, drainage, spraying, and other factors in connection with orcharding. Vegetable growing, particularly the culture of melons, tomatoes, onions, and lettuce, is being studied, and extensive experiments with carnations to test the value of commercial fertilizers and methods of application are in progress.

In agronomy the plant breeding work with corn and clover was continued, and breeding experiments with wheat, oats, and other crops were begun.

The corn-breeding work during the past ten years was summarized in a bulletin during the year. Starting with a single variety it has been possible in ten generations to increase the protein content from 10.92 per cent to 14.26 per cent, and by breeding in the opposite direction the protein content was reduced from 10.92 to 8.64 per cent. Similarly, the oil content was increased in one strain of the original variety from 4.70 to 7.30 per cent, and decreased in another strain to 2.66 per cent.

Particular attention was given during the year to a study of the molds or ear rots of corn. Two species of fungi were found associated with this disease and they appear to winter over in the old cornstalks. A new fungus disease of wheat is under observation and some diseases of apple trees are also receiving attention.

Work is in progress on about twenty-five experiment fields in different parts of the State. About one-half of this number of fields is at present under permanent lease and two or three have been deeded to the institution free of cost. The policy of the station to have at least two representatives at each farmers' institute held in the State is upheld, and is proving a very efficient means of bringing the results of research to the people. Only the results of station investigations are discussed by the station officers.

The publications received from this station during the year were as follows: Bulletins 126, Distance between hills for corn in the Illinois corn belt; 127, A study of the factors influencing the improvement of the potato; 128, Ten generations of corn breeding; 129, Market classes and grades of sheep; 130, Experiments with repellents against the corn root aphid, 1905-6; 131, Habits and behavior of the corn field ant (*Lasius niger americanus*); 132, The effect of selection upon certain physical characters in the corn plant; 133, Ear rots of corn; and 134, The insect pests of clover and alfalfa; Circulars 118, Cows versus cows; 119, Washing of soils and methods of prevention; 120, Spraying apple orchards for insects and fungi; 121, Lighting country homes by private electric plants; 122, Seven years' soil investigation in southern Illinois; 123, The status of soil fertility investigations; 124, Chemical principles of soil fertility; 125, The sheep industry from the market standpoint; 126, Food requirements of growing and fattening swine; 127, Shall we use natural rock phosphate or manufactured acid phosphate for the permanent improvement of Illinois soils; 128, Abstract of the proceedings of the conference on animal tuberculosis at the University of Illinois, October 15, 1908; 129, The use of commercial fertilizers; and 130, A phosphate problem for Illinois landowners; and the Annual Report for 1908.

The income of the station during the past fiscal year was as follows:

United States appropriation, Hatch Act-----	\$15,000.00
United States appropriation, Adams Act-----	11,000.00
State appropriation-----	102,500.00
State appropriation, balance from previous year-----	9,082.00
Farm products-----	14,576.05
Farm products, balance from previous year-----	11,407.08
Total-----	163,565.13

A report of the receipts and expenditures for the United States funds has been rendered in accordance with the schedules prescribed by this Department and has been approved.

The work of the Illinois Station continues to develop along both practical and scientific lines, and a large amount of investigation is in progress. The extensive equipment and ample resources are powerful factors in promoting the efficiency, and are at the same time evidence of how the efforts of the station are appreciated by the public.

INDIANA.

Agricultural Experiment Station of Indiana, Lafayette.

Department of Purdue University.

ARTHUR GOSS, M. S., A. C., *Director.*

The year at the Indiana Experiment Station was marked by extensive additions to the equipment of the institution and by the advent of greater assistance in the form of increased appropriations by the State. The new station building (Pl. IV, fig. 1) was equipped, dedicated, and occupied during the year, and the last legislature increased the appropriations for the institution from \$25,000 to \$75,000 annually. Of this amount \$15,000 is to be used for soil and crop improvement, \$10,000 for dairying, \$5,000 for poultry work, \$10,000 for other live-stock interests, \$5,000 for the investigation of hog cholera and other animal diseases, and \$10,000 for horticultural experiments. Of the remainder of the appropriation, \$10,000 is to be available for general expenses and \$10,000 for extension work. Part of the appropriation will be taken for the purchase of some land for the exclusive use of the station, and from the state fund for crop and soil investigations a new building for seed and fertilizer work is being provided.

Few changes took place in the station staff. P. H. Crane was appointed assistant in dairy field work at the station, and C. Cutler, of the Vermont Station, as assistant state chemist in the feeding-stuffs control work.

The Adams fund projects of the station were carried on systematically, and a new one on the factors influencing condensed milk was



FIG. 1.—NEW ADMINISTRATION AND LABORATORY BUILDING AT THE INDIANA STATION.



FIG. 2.—NEW ADMINISTRATION AND LABORATORY BUILDING AT THE TEXAS STATION.

added during the year. Another, relating to a phase of butter making, was added at the close of the year. The investigations on rusts were carried forward along the original lines, special studies being made during the year on the rusts attacking timothy. By means of culture and other experiments, the life histories of a considerable number of rusts have been worked out. Results from the hog-cholera investigation indicated that dieting is very desirable in connection with serum treatment. The manufacture and standardization of serum is provided for by state funds. No work was done in 1909 on the cornstalk-disease project.

Among the lines of experimentation carried on under the Hatch and other funds, the agriculturist reports breeding experiments by hybridization and selection with cereals, alfalfa, soy beans, and cowpeas, tests of various cropping systems, cooperative work with about 1,000 farmers in testing improved varieties of grain, experiments in the introduction of forage crops, and tests of implements for corn culture. The different experiments with corn in progress involved the type of ear for seed corn, effect of detasseling, relative value of seed corn, harvesting at different stages of maturity, and similar questions. The results of cooperative tests of varieties of corn, wheat, oats, soy beans, and cowpeas in 1908 were published during the year. The object of this work is to compare the several varieties in each test under the same conditions without any special effort to secure large yields.

In animal husbandry the studies of beef and pork production and the maintenance of breeding ewes and brood sows were continued. The results of three experiments indicated that corn silage may profitably be used as a portion of the ration in finishing steers. The addition of corn silage to a ration of shelled corn and clover hay resulted in a more rapid and a cheaper gain, although a larger gain was secured when no corn silage was fed. A comparison of short and long feeding periods is also in progress.

The horticultural work of the station was largely confined to experiments in spraying for insect pests and fungus diseases and to studies of certain problems in orchard management. Some cooperative work with melons, especially cantaloups, was carried on, and experiments with onions, tomatoes, and other special crops, and with growing catalpa and locust trees for fence posts, were made. The chemical department cooperated with the other departments in experiments on the fertilizer requirements of crops, soil-improvement work, studies on soil acidity, and the effect of methods of application of fertilizers on the composition of potatoes and the protein content of corn. In the state chemical laboratory, investigations were made on feeding stuffs and fertilizers, and 2 bulletins on these subjects were issued during the year.

The dairy department, in addition to the research work under the Adams fund, is endeavoring to devise satisfactory methods of testing cream for butter fat and to determine their accuracy. Generally accepted methods for the estimation of fat in unsweetened evaporated milk were so modified as to give results more nearly correct, and a bulletin on the subject was issued. Experiments by this department also indicated that the official standard calling for 28 per cent solids in unsweetened evaporated milk is too high and not practical.

The extension work is organized as a department of the station, but is wholly supported by state funds. The different lines of work with which the agricultural extension department is connected are short courses in congressional districts of the State, educational trains, excursions to the university and the station, exhibits at state and county fairs, young people's clubs and contests, public school agriculture, county farms, and agricultural meetings. During the year one soil and two corn specials were run over three different railroad lines. Short courses were held in two congressional districts, five county excursions to the station were conducted, a variety test of corn was made on two county farms, and assistance in various ways was given public-school teachers in teaching agriculture.

The publications received from this station during the year were as follows: Bulletins 126, Supplements to corn for fattening hogs in dry lot; 127, Records from Indiana dairy herds; 128, The small fruits; information concerning their culture; 129, Winter steer feeding; 130, Results of short versus long feeding periods; 131, Concentrated commercial feeding stuffs; 132, Results of cooperative tests of varieties of corn, wheat, oats, soy beans, cowpeas, 1908; 133, Commercial fertilizers; 134, The estimation of fat in unsweetened evaporated milk by modified methods; and 135, Growing better gems; Circulars 11, Milk production. I, Herd improvement; 12, Beef production. II, Methods of beef production in Indiana; 13, Milk production. II, Feeding; 14, Beef production. III, Factors influencing the value and cost of feeders; and 15, Growing onions from seed.

The income of the station during the past fiscal year was as follows:

United States appropriation, Hatch act.....	\$15,000. 00
United States appropriation, Adams act.....	11, 000. 00
State appropriation for the fiscal year ended September 30, 1909.....	53, 194. 44
Miscellaneous.....	33, 255. 64
Balance from previous year, miscellaneous.....	12, 239. 86
Total	124, 689. 94

A report of the receipts and expenditures for the United States funds has been rendered in accordance with the schedules prescribed by this Department and has been approved.

The excellent equipment, effective organization, and generous support from the State add to the prosperity of the Indiana Station and

enable it to extend and enlarge the already numerous and useful lines of work conducted on its own premises as well as throughout the State. The cooperative support of the farmers and their interest in the station's work continue to increase and bring about a wider and more general consideration of the results secured and the advice given.

IOWA.

Iowa Agricultural Experiment Station, Ames.

Department of Iowa State College of Agriculture and Mechanic Arts.

C. F. CURTISS, M. S. A., *Director*.

Little change was made in the lines of work of the Iowa Station, which covers a wide range, but important addition was made to its equipment, and a number of changes in the personnel took place.

The new agricultural building was formally dedicated June 9, 1909. In this new four-story structure is located most of the agricultural work of the college and the station, including the departments of animal husbandry, soils, farm crops, horticulture and forestry, agricultural extension, agricultural chemistry, and agricultural journalism.

The following changes occurred on the station staff: E. T. Robbins, assistant animal husbandman, who resigned to take up editorial work on a well-known agricultural journal, was succeeded by H. H. Kildee. I. O. Schaub, of the soils section, accepted a position at the North Carolina Station and was succeeded by S. L. Jodidi, of the Michigan Station, and A. A. Wells. M. Mortensen was appointed acting head of the dairy department, vice G. L. McKay, resigned. J. Bower, assistant dairyman of the station, resigned to engage in commercial work. L. G. Michael resigned as chemist to accept a position with the Russian Government as special expert in connection with corn-breeding work in Bessarabia. H. G. Van Pelt, assistant animal husbandman, was succeeded by A. Leitch.

The Adams fund projects previously outlined were further developed, but otherwise remained unchanged. In most of the work very complete photographic records were made in addition to the general records ordinarily kept. In the apple-breeding project, chemical analyses of the crossbred apples and their parents were made to determine unit characters. The beef cattle breeding work has resulted in a considerable number of offspring through mating Polled Blue Gray heifers, White Shorthorn, Red Shorthorn, and Galloway cows, with Blue Gray bulls of the first cross. These crosses have already brought out some interesting points regarding the transmission of various characters, especially color and polled characteristics. The young animals secured in connection with the project on the improvement of native unimproved cows by means of feed, environment, and breeding are already showing marked progress. The

capacity of these animals to digest and assimilate feeding stuffs will be compared with the same character in good representatives of the best beef and dairy breeds. A method of investigation was worked out for the project on the relation of humus to crop production under different systems of soil management.

A considerable number of experiments were carried on by the various departments of the station with the Hatch fund. The department of horticulture continued its experiments with apples and plums in cooperation with individuals, the state horticultural society, and this Department. Observations on cold storage for Iowa-grown apples were brought to a close and the results prepared for publication. Other lines of work still in progress included experiments with apple stocks for orchard top working in Iowa, with the sand cherry as a stock for the plum and cherry, and with other stocks for use in orchard and nursery. A study was also made of orchard varieties and of trees and shrubs for ornamental planting and for groves and windbreaks. The work in forestry was continued as previously planned.

The chemist, who is cooperating with the animal husbandry department, continued the study of the cause of calculi in sheep, together with digestion experiments with pigs to determine the effect of stock foods combined with corn. Observations on the sugar content of pumpkins of different generations were also made. The investigations on the corrosion of fence wire in cooperation with the department of agricultural engineering were completed, and the results are soon to be published.

The department of soils and farm crops was consolidated into a department of agronomy. The work in soils and farm crops during the past year was along the same lines as heretofore. The investigations on the peaty swamp soils of Iowa were completed.

The department of animal husbandry brought to a close the experiments with corn silage for fattening steers, and an investigation to determine the value of succulent feed for lambs was made. Among other studies made by this department may be mentioned sheep feeding, milk production of sheep, and feeding experiments with work horses and with hogs. In dairy husbandry the individuality of cows of different breeds was studied, and feeding experiments with calves to determine methods for rearing them without milk were conducted. (Pl. V, fig. 1.)

The poultry work was principally along the line of breeding for increased egg production. Work was also done on feeding and management of poultry for meat production, the determination of sex of the chick before hatching by examination of the air cell during incubation, and on methods of caring for chicks in the brooder.

The botanist continued the testing of seeds and the studies of fungus diseases and of weed eradication.



FIG. 1.—DAIRY BARN OF THE IOWA STATION.

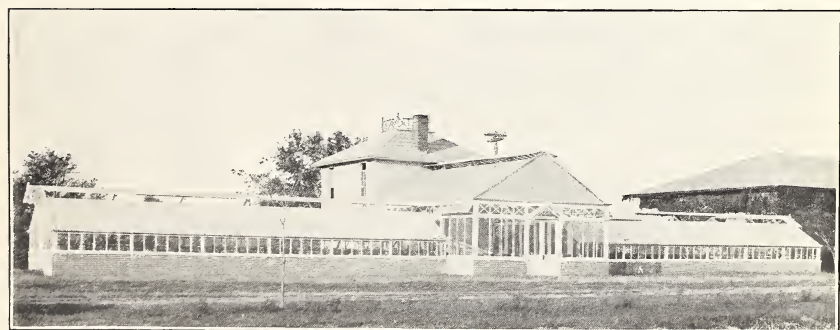


FIG. 2.—NEW GREENHOUSE AT THE LOUISIANA UNIVERSITY AND STATION.

The experimental work of the dairy department dealt with moisture in butter, use of starters in butter making, and general errors in sampling and testing. Bulletins on moisture content of butter and the use of starters in butter making were published during the year.

The entomologist completed the study of the life history and treatment of the lesser apple leaf folder (*Peronea minuta*), and published a bulletin on the subject. Work was continued on the oyster-shell scale and the apple leaf hopper, and attention was also given to the methods of spraying for the codling moth.

In agricultural engineering studies relating to the construction of concrete silos were continued. Engine tests with denatured alcohol were made and trials of grain grading and cleaning machinery, windmills, and other machinery were conducted. A bulletin on modern silo construction was published during the year. The experiments in sewage irrigation in cooperation with this Office underwent further development.

As already mentioned, the Iowa Station cooperates with this Department in work on sewage irrigation, plant breeding, preservation and treatment of farm timber supplies, and with county farms and prominent farmers in studying the soil types of the State, together with methods of maintaining their fertility. The extension department of the college was maintained by a state appropriation of \$32,000. This work is carried on by a corps of 21 instructors, 14 devoting their entire time and the rest five or six months during the winter season to this distribution of practical information to the farmers. The members of the experiment station staff do not devote any time to extension work.

The publications received from the station during the year were as follows: Bulletins 97, Methods of determining the moisture content of butter; 98, Clover growing in the loess and till soils of southern Iowa; 99, Results of seed investigation for 1907 (with popular edition); 100, Modern silo construction; 101, A study of moisture in butter; 102, The lesser apple leaf-folder; 103, The use of starters in butter making; Biennial Reports for 1902-3 and 1904-5; and the Annual Report for 1906.

The income of the station for the past fiscal year was as follows:

United States appropriation, Hatch Act.....	\$15,000.00
United States appropriation, Adams Act.....	11,000.00
State appropriation.....	25,000.00
Balance from previous year, state appropriation.....	2,421.91
Farm products.....	10,224.56
Miscellaneous	511.60
Total	64,158.07

A report of the receipts and expenditures for the United States funds has been rendered in accordance with the schedules prescribed by this Department and has been approved.

The Iowa Station continues to be in a prosperous condition, and to do a large amount of useful work for the benefit of the agriculture of the State.

KANSAS.

Kansas Agricultural Experiment Station, Manhattan.

Department of Kansas State Agricultural College.

E. H. WEBSTER, M. S., *Director*.

A number of changes occurred in the station staff, the principal one being in the directorship, E. H. Webster, formerly chief of the Dairy Division of this Department, taking charge as director January 1, 1909. O. A. Stevens, who was appointed assistant botanist, but resigned later in the year to become assistant in charge of the newly established seed inspection laboratory at the North Dakota Station, was succeeded by W. E. Davis. J. C. Cunningham was appointed assistant horticulturists, J. B. Parker, assistant entomologist, T. R. H. Wright, assistant in animal nutrition, and A. Miyawaki, assistant in dairying. C. K. McClelland, superintendent of the Fort Hays substation, resigned to take effect January 1, 1910, and the station is to be placed in charge of A. M. Ten Eyck. The work at this substation is to be materially enlarged.

The State made an appropriation for the station of \$30,000 for the biennium 1910-11, which is the first state appropriation to be received by it.

Work on the different Adams fund projects was conducted during the year, and varying progress was reported. No new projects were undertaken. The study of cerebritis in horses received but little attention. Much of the time of the veterinary department was taken up with the construction and equipment of the new veterinary building. The better facilities available for the following year give promise of greater progress. The hog-cholera work was carried forward but no definite results have as yet been obtained. The results of observations with reference largely to the use of horse serum in the treatment of hog cholera were published as a report of progress.

The entomologist continued his investigations of the Hessian fly and of plant lice injuries to wheat and corn. A special study was made of the green bug and of methods of controlling the pest by means of a parasite. Special laboratory appliances were devised for this work and field experiments paid for from other funds were conducted as supplementary to this project.

Further work was done by the department of chemistry on the digestibility and nutritive value of Kansas feeds. Digestion experiments were conducted with 4 sheep fed alfalfa and prairie hay in various combinations and a report on the work was prepared. The nitrogen balance was determined in addition to other data collected in a digestion experiment with two steers.

The wheat-breeding work was carried forward as previously planned. More ground was allotted for the work, and laboratory apparatus was designed for special color tests and for testing the hardness of grain. A special system of treatment was devised and attention was given in particular to the inheritance of characters. The yellow berry of wheat was studied in this connection to determine its true character and the extent to which it is hereditary. The possibility of breeding pure strains of wheat free from the yellow berry under all conditions was discussed in a bulletin.

In a number of other lines supported by Hatch and state funds substantial progress was made. The veterinary department in addition to regular work carried on some experiments relating to opsonic index and contagious abortion in cattle. The new veterinary building furnishes better facilities than heretofore for that department's work.

The department of entomology and zoology paid special attention to the corn earworm. An effort was made to determine the most injurious broods, and trials were made of methods of repression. The damage done by moles and mice, particularly in cornfields, was considered together with means for reducing or preventing injuries of this kind. Certain phases of the Hessian-fly work were conducted in cooperation with this Department, and a station was maintained for the purpose at Wilson. The mound-building prairie ant, which is troublesome mainly in alfalfa fields, was studied, and a description of its habits, together with directions for its destruction, published in bulletin form.

The department of agronomy conducted fertilizer experiments with corn, wheat, oats, and alfalfa, together with work on the preparation of the seed bed and the cultivation of wheat and corn. Other activities of this department included variety tests, selection, grading, and distribution of seed and rotation experiments.

A feeding experiment by the dairy husbandry department pointed out the efficiency and low cost of feeding alfalfa hay and corn silage as compared with mill feeds. Studies were also made relative to the cause of irregularities in results secured with the Babcock test and to the moisture content of creamery butter. The animal husbandry department conducted feeding experiments with cattle, hogs, and sheep to determine the relative values of alfalfa hay and meal,

with the result that apparently the meal has no advantage for the Kansas farmer. Dry and wet feed for hogs were compared and so far in the course of the experiment wet feed has been most advantageous. For three years the birth weight of pigs from sows of different ages has been recorded.

The horticultural department pursued experiments in spraying for San José scale, summer pruning, and fertilizers for sweet potatoes. Observations on the development of fruit buds, distance of planting, and pollination were also made.

The bacteriologist studied the effect of the depth of cultivation on the number of soil bacteria in upland and lowland soils cultivated from 2 to 12 inches deep. Samples were obtained each week and temperature and moisture determinations were also made.

The cooperative work of the station is limited to certain experiments with farmers on hog cholera and with this Department in dry-farming studies at the Fort Hays and Garden City substations. The extension work is conducted by an extension department, and the station officials act only in advisory capacity.

The following publications were received from the station during the year: Bulletins 153, Deterioration of Red Texas oats in Kansas; 154, The mound-building prairie ant; 155, Alfalfa; 156, The yellow berry problem in Kansas hard winter wheats; 157, Studies on hog cholera and preventive treatment; and Circular 1, Treating seed corn to protect it from burrowing animals.

The income of the station during the past fiscal year was as follows:

United States appropriation, Hatch Act-----	\$15,000.00
United States appropriation, Adams Act-----	11,000.00
State appropriation for substation-----	25,000.00
Fees-----	8,306.15
Farm products-----	7,234.47
Miscellaneous-----	644.54
Balance from previous year, other than federal funds--	6,672.06
Total-----	<hr/> 73,857.22

A report of the receipts and expenditures for the United States funds has been rendered in accordance with the schedules prescribed by this Department and has been approved.

A recent reorganization of the Kansas Station has resulted in material improvement from the standpoint of administration and supervision of the work. The station is broadening its sphere, and is making its activities along established lines more systematic and efficient.

KENTUCKY.

Kentucky Agricultural Experiment Station, *Lexington.*

Department of the State University.

M. A. SCOVELL, M. S., Ph. D., *Director.*

The work of this station was in general along the lines followed in 1908. Out of the fees arising from the fertilizer and feeding stuffs control a farm costing \$7,000 was purchased and a new piggery with numerous feeding lots was provided. Other general and minor improvements were made during the year in the experimental fields and about the station buildings. Facilities for examining drugs under the state law were provided in the food laboratory of the station. W. H. Scherffius, head of the agricultural division, resigned to take up work in South Africa, and L. A. Browne, of the North Dakota Station, was added to the staff as chemist in the drug division.

The Adams fund projects were continued as originally planned. The number of broods and some other facts in the life history of the corn earworm have been worked out, and the results are nearly ready for publication. Additional data were obtained in support of the conclusions as to the identity of the organisms causing nodules on alfalfa and sweet clover and the identity of the organisms on red and white clover. Satisfactory proof was also secured of the identity of the organism causing nodules on alsike clover with that on red and white clover. The forms of organisms on cowpeas and soy beans were found distinct from those on the clovers. Some preliminary work was begun on the study of milk fever in dairy cows, and this is to be carried forward as circumstances permit. Some progress in soil studies is reported, much of the time having been given to the study of methods of determining potash.

The activities under the Hatch and other funds included experiments with breeding, growing, and curing tobacco; tests with forage plants of various kinds; special studies on alfalfa and soy beans; crop-rotation trials; breeding and culture experiments with wheat; corn, barley, oats, and potatoes; soil studies; studies of insect and fungus pests; pig breeding and feeding; hog-cholera immunization, and related lines of work. Tests of various sheep dips against scab were reported in a bulletin published during the year, in which the use of dips made of lime and sulphur, tobacco and sulphur, or one of the coal-tar dips was recommended. Tobacco or coal-tar preparations were found to be more effective than the lime and sulphur dip in destroying the sheep tick or louse, in addition to being a satisfactory treatment for sheep scab. In tobacco experiments it was found that phosphates gave appreciably better gains than potash salts on soil typical of much of the tobacco soil of western Kentucky, and that nitrates tended to reduce the crop by causing a less perfect stand.

A large amount of cooperative work was carried on with farmers of the State, with other stations, and with this Department. The work throughout the State comprised experiments with tobacco fertilizers and with grasses and other forage plants, while in conjunction with this Department studies of systems of rotation, tests of varieties of corn, barley, and hybrid oats, culture experiments and breeding work with tobacco, and the treatment of hogs with serum against hog cholera were carried on. Soil and fertilizer work was also conducted in connection with the state geological survey.

A small amount of institute work is done by the younger men of the station staff, under the auspices of the state board of agriculture.

The publications received from the station during the year were as follows: Bulletins 132, Commercial fertilizers; 133, Spraying apple trees. Apple-orchard pests in Kentucky; 135, Wheat: Test of varieties. Chemical study of varieties; 136, Commercial fertilizers; 137, The army worm; 138, Commercial fertilizers; 139, Tobacco cultivation, curing, and marketing; 140, Fertilizers; 141, Concentrated commercial feeding stuffs; 142, Carnation root knot; and 143, Sheep scab; and the Annual Reports for 1906 and 1907.

The income of the station during the past fiscal year was as follows:

United States appropriation, Hatch Act-----	\$15,000.00
United States appropriation, Adams Act-----	11,000.00
State appropriation, food control-----	22,784.32
Fees, including balance from previous year-----	33,281.39
Farm products, including balance from previous year--	11,458.18
Miscellaneous, including balance from previous year--	174.33
Total-----	93,698.22

A report of the receipts and expenditures for the United States funds has been rendered in accordance with the schedules prescribed by this Department and has been approved.

The numerous practical lines of work of the Kentucky Station are having their beneficial effect on the agriculture of the State. The inspection and control work are separated from experimentation and research, but contribute considerable revenue to the station.

LOUISIANA.

- No. 1. Sugar Experiment Station, *Audubon Park, New Orleans.*
- No. 2. State Experiment Station, *Baton Rouge.*
- No. 3. North Louisiana Experiment Station, *Calhoun.*
- No. 4. Rice Experiment Station, *Crowley.*

Department of Louisiana State University and Agricultural and Mechanical College.

W. R. DODSON, A. B., B. S., *Director, Baton Rouge.*

The Louisiana stations pursued work along lines previously laid down and no new investigations were inaugurated during the year.

The following changes in the staff took place: J. G. Lee, sr., resigned as assistant director of the North Louisiana Experiment Station at Calhoun, and J. B. Garrett, formerly assistant entomologist of the stations, was appointed to the vacancy. R. E. Graham, W. D. Reid, and S. W. Plauche were appointed assistants in chemistry, G. Tiebout, assistant in horticulture, and E. M. Percy, assistant in mechanical engineering in connection with work on sugar-house machinery. B. F. Hochenedel resigned as assistant chemist to engage in commercial work. Since the close of the fiscal year, P. A. Yoder resigned as research chemist and W. Newell as entomologist, the latter to accept a similar position at the Texas Station. A new greenhouse (Pl. V, fig. 2), costing about \$6,000, was constructed at the State Station at Baton Rouge, and a residence for the farm manager, at an expense of about \$1,500, was built at the Calhoun Station.

A substation for rice culture was established at Crowley and work was begun during the spring of 1909. This station is conducted in cooperation with this Department. Local parties gave 60 acres of land for the use of the station and subscribed \$3,500 for buildings. The legislature authorized its establishment by an act passed July 1, 1908, but no appropriation for the purpose was made at that time. F. C. Quereau was called from the University of Tennessee to the position of assistant director in charge of this station.

The research work carried on with the Adams fund included, among other lines, investigations on a number of plant diseases. Some work was done on rice smut and rice blast, and material for study was secured. The wilt disease of pepper was given a good deal of attention and the life history of the soft rot of cotton was studied. Work on cotton wilt included breeding for resistance, better lint, and earlier and more dwarfed types. Efforts were also put forth to determine why alfalfa is difficult to grow at the station. Liming was tried and 42 varieties obtained from this Department were put under test to ascertain their resistance to the unfavorable conditions.

Observations made on cerebro-spinal meningitis in horses were summarized and published as a preliminary report. Work on anthrax was concentrated on the production of superimmunized animals for the purpose of obtaining serum that can be used in hastening the development of immunity from the disease.

Progress was made in the study of the nonsugars of sugar cane, and new methods considered thoroughly accurate were worked out for determining the amount of certain organic acids in the cane. More reliable methods than those previously in use were also devised for determining formaldehyde in sugar products. The results secured pointed to the possibility of formaldehyde being a normal constituent of cane juice, and it was observed that at the temperature of evaporation of the juice formaldehyde is formed.

The bacteriological work on the inversion of sugars consisted of studies of organisms and the changes they caused in sugars secured from various sources. Collections of sugar-inverting micro-organisms were made, and data regarding the conditions under which they were most active were secured. The influence of some of the products of decomposition on the polarization of fluids containing them was studied with a view to finding means for rendering sugar products less subject to deterioration from these causes.

During the year Prof. E. W. Kerr, head of the department of mechanical engineering in the university, entered upon a series of investigations on the conditions most conducive to complete combustion of bagasse in sugar-house furnaces.

Work with Hatch and other funds was conducted at the different stations. At the sugar experiment station, as heretofore, attention was devoted primarily to work with sugar cane, which included physiological experiments, fertilizer, culture, variety, irrigation, and rotation tests, and the production of seedlings. The sugar-house work had reference mainly to clarification, use of formaldehyde in the factory, and to other similar lines. In addition to this work, tests of forage crops, fiber plants, and semitropical fruits were continued.

At Baton Rouge experiments were made with steers to test the digestibility of lespedeza, molasses, Bermuda grass, low-grade cottonseed meal, corn chops, mangels, and carrots. In dairy husbandry experiments were conducted to determine the milk-producing value of different rations, consisting in part of potatoes, beets, and carrots. In agronomy, fertilizer, culture, and variety tests were conducted with cotton, corn, oats, and forage crops. Considerable attention was given to the profitable production of beef and pork from local crops and feeds. The horticultural work consisted mainly of testing varieties of comparatively new plants, among them vegetable pears and bur artichokes. Experiments were also made to determine the influence of variety, fertilization, cultivation, and handling on canned tomatoes.

At Calhoun principal attention was given to fertilizer, culture, and variety tests with cotton and with cereals and leguminous crops. The grazing value of peanuts, soy beans, cowpeas, and Bermuda grass was compared, and methods of applying manure were tested.

The stations conducted fertilizer experiments in cooperation with planters in the State on different types of soil and cooperated with this Department in testing 300 Japanese oil plants, together with varieties of soy beans, fiber plants, vegetables, and peanuts. The new rice culture station also cooperates with this Department in certain lines of work.

The following publications of the stations were received by the Office during the year: Bulletins 106, A preliminary report on the so-called cerebro-spinal meningitis of horses; 107, Preliminary tests of sugar-house machinery; 108, A preliminary report on some diseases of chickens; 109, Experiments with *Bacterium anthracis*, anthrax vaccines, and hyperimmunization; 110, Comparison of cotton-seed meal and hulls with cold pressed cake as a dairy feed; 111, Rotation experiments with cotton, corn, cowpeas, and oats; 112, Orchard report of Baton Rouge Station; 113, Analyses of commercial fertilizers and Paris green; and 114, Analyses of commercial feeding stuffs; Geological Survey Bulletins 6, Cartography of southwestern Louisiana with special reference to the Jennings sheet; 7, Rock salt: Its origin, geological occurrences, and economic importance in the State of Louisiana; and the Annual Report for 1908.

The income of the station during the past fiscal year was as follows:

United States appropriation, Hatch Act-----	\$15,000.00
United States appropriation, Adams Act-----	11,000.00
State appropriation-----	9,166.65
Balance from previous year, state appropriation-----	5,576.05
Fees-----	11,846.65
Farm products-----	4,360.65
Miscellaneous-----	600.00
Total-----	57,550.00

A report of the receipts and expenditures for the United States funds has been rendered in accordance with the schedules prescribed by this Department and has been approved.

The work of the Louisiana stations touches the principal agricultural industries of the State and is being highly appreciated. This work is being more carefully systematized, the researches under the Adams fund are being well supported, and the funds of the institution are carefully administered.

MAINE.

Maine Agricultural Experiment Station, Orono.

Department of the University of Maine.

C. D. Woods, Sc. D., Director.

As in previous years the Maine Station devoted its efforts principally to a few subjects—studies on the potato, corn, the apple, and poultry constituting the principal lines of work. Only a few changes in the organization took place. At the close of the year the entomological department was strengthened by the appointment of O. A. Johannsen as associate entomologist, and A. G. Durgin was appointed assistant chemist to fill the vacancy made by the resignation of Miss J. C. Colcord. Since the close of the fiscal year W. W. Bonns was appointed assistant horticulturist.

The state legislature of 1909 passed an act appropriating \$10,000 for the purchase and equipment of a farm, and requiring the station to conduct there experiments in orcharding and on the culture of corn and other farm crops. The Highmoor farm at Monmouth (Pl. II, fig. 2), about 100 miles southwest of Bangor, was purchased for the purpose, and it is planned to begin work in 1910. The farm consists of 225 acres, of which 60 acres are now in apple orchards, 75 acres additional under tillage, and the balance in pasture and woods. The station work in orchard management, owing to lack of facilities, has been interrupted for three years, but will now be taken up again on this farm by the newly appointed associate horticulturist. The State has also provided for printing the bulletins and reports of the station, an appropriation of \$4,500 per annum having been made for this purpose.

In its Adams fund work the Maine Station has made good progress. The poultry investigations have pointed out that egg productivity is inherited in a manner not hitherto recognized for sexually reproducing animals. Breeding work based on the knowledge gained has been inaugurated. A thorough study has also been made of a series of factors which influenced the fertility of eggs, and it has been demonstrated that the hatching quality of fertile eggs is a character which is definitely inherited. Progress in a physiological study of the oviduct in a laying hen is reported and the data collected will soon be published as a monographic account of the correlation and development of the hen's egg, such as size, bulk, color, and fertility. A study of the Mendelian principles of transmission is being made in crosses between Indian Game and Barred Plymouth Rock fowls, about 100 fowls being under observation.

The results of breeding work with sweet, dent, and flint corn seem to indicate that environment is a more potent factor than heredity, and that local adjustment is necessary in corn improvement. Advance in time of maturity secured through selection was not held when the corn was grown in other localities. The work of the entomologist on the plant lice of Maine, especially the pea aphid (*Macrosiphum pisi*), the potato aphid (*M. solanifolii*), and *Pemphigus tessellata*, has been continued as a project under the Adams fund. The investigation of fungus gnats, Mycetophilidæ, with reference to their life history, economic relationships, morphology, and ecology was also taken up as an Adams project.

In studying the blackleg disease of potatoes, the organism which also causes a soft rot of the tubers has been isolated and a typical form of the disease produced by inoculations with pure cultures. The vegetable pathologist in his investigations on the interrelation of leaf spots, fruit rots, and canker of apple trees has made a distinct contribution to the life history of *Coryneum foliicolum* and

Phoma mali, and has completed an extended study of the cultural characters of these two fungi on different culture media. In addition to these fungi, others associated with these plant diseases are studied to determine their relationships and to work out the life history of each. In connection with this work it has been found that certain fungi, either not described or hitherto not considered, are of economic importance.

The Hatch work of the station included a careful study by the entomologist of a remarkable outbreak of the saddled prominent (*Heterocampa guttivitta*) and the results of this work are fully recorded in a bulletin published during the year. The true sexes of *Pemphigus tessellata* were discovered for the first time, the alternate host for the species ascertained, and the identity of *P. acerifolii* as the same species established. These results have been partly published in other than station publications.

The vegetable pathologist found it inadvisable to apply even small quantities of lime to Aroostook potato soils on account of the resulting increase in potato scab. He made the observation that the crotch injury of apple trees in Maine is a form of winter injury and is not caused by *Bacillus amylovorus*; and further it was ascertained that self-boiled lime-sulphur mixture is of value as a preventive of apple scab, but is not as efficient as Bordeaux mixture. These results have all been published in bulletin form. Weather records with reference to winter injury of fruit trees show as a general rule for that section a fairly well-defined minimum temperature below which certain varieties of apples can not endure. Less danger is found to result from continued low temperature than from abrupt changes from mild to low temperatures.

The inspection work of the station is kept quite distinct from investigational duties.

The following publications have been received during the year: Bulletins 158, Food of man studies; 159, Appliances and methods for pedigree poultry breeding; 160, Fertilizer inspection; 161, The saddled prominent; 162, Insect notes; 163, Finances, meteorology, index; 164, Notes on plant diseases, 1908; 165, Poultry notes; 166, Inheritance of fecundity; and 167, Field experiments, 1906-1908.

The income of the station during the past fiscal year was as follows:

United States appropriation, Hatch Act-----	\$15,000.00
United States appropriation, Adams Act-----	11,000.00
Farm products, etc-----	1,902.00
For cooperative poultry investigations with the U. S. Department of Agriculture-----	1,000.00
Inspection fees-----	9,500.00
Balance from previous year, other than federal funds--	1,830.41
Total-----	40,232.41

A report of the receipts and expenditures for the United States funds has been rendered in accordance with the schedules prescribed by this Department and has been approved.

The Maine Station is prosecuting scientific and practical lines of work in an effective manner, and with the gratifying aid of the State is prepared to enter upon even broader fields of usefulness.

MARYLAND.

Maryland Agricultural Experiment Station, College Park.

Department of Maryland Agricultural College.

H. J. PATTERSON, B. S., *Director.*

The Maryland Station made steady progress during the year in broadening and strengthening its work mainly along the lines pursued in previous years. Some additions to equipment and some changes in the staff were made. N. Schmitz, of the Bureau of Plant Industry of this Department, was appointed agronomist. G. E. Gage, of Yale University, was appointed associate biologist to investigate poultry diseases, and a well-equipped laboratory was fitted up for this purpose. C. W. Melick resigned as dairyman, and P. M. Novik, assistant horticulturist, was killed December 9 in a railroad accident. A. L. Stabler, a graduate of the college, was appointed assistant in animal husbandry in connection with investigations with hogs and sheep. R. B. Mayo, assistant pathologist, resigned to engage in private work. Frank Kent succeeded the late J. R. Owens as treasurer of the college and station. Shortly after the close of the year L. W. Fetzer, assistant chemist, resigned to accept a position in this Office. Considerable improvement was made in the equipment for the poultry investigations.

The Adams fund projects of the station were increased by the addition of a study of the rate of diffusion of different lime compounds in the soil and of the effect of the internal application of different substances on the structure and physiology of plants. Work on the older projects, namely, those relating to city milk supplies, parasitic hymenoptera with special reference to the Braconidæ, effects of fertilizers on cell structure of plants, and embryology of chickens, was actively carried on during the year. The investigations on poultry diseases were materially modified and now include, instead of studies of specific diseases, a fundamental inquiry into the bacterial flora of chickens in health and disease, beginning with observations on the bacterial and animal parasites in the intestinal contents of healthy fowls from incubation to maturity. As in previous years, much the larger proportion of the Adams fund was devoted to the investigations relating to milk supply and embryology and diseases of chickens.

In addition to the Adams fund projects, the station conducted investigations and experiments on a wide range of subjects, including breeding alfalfa for seed production; tests of alfalfa seed from different sources; fertilizer and culture tests with alfalfa; breeding and tests of seed from different sources with red, mammoth, alsike, and white clovers; breeding, variety tests, harvesting, and thrashing cowpeas, and the culture of cowpeas with corn.

The new lines of work in agronomy taken up during the year included breeding of sweet corn, study of the cause of dying out of alfalfa fields, and growing hairy vetch for seed. The variety tests with corn were made at the station farm and in cooperation with 12 farmers in different parts of the State. Experiments with alfalfa were made in cooperation with the Bureau of Plant Industry of this Department. Tests of varieties, improvement by selection and breeding, and fertilizer and rotation experiments with tobacco were also made in cooperation with the Bureau of Plant Industry.

In the horticultural department experiments were made on the breeding, fertilizing, and spraying of apples, with tests of cover crops for apple orchards; on varieties of peaches, breeding of pears, tests of seedling papaws, and pruning and training raspberries; variety tests, seed selection, mulching, spring cultivation, and preservation (for exhibit purposes) of strawberries; adaptability and pruning of pecans; varieties and grafting and budding of Persian walnuts; fertilizers for asparagus; variety tests, fertilizing, and breeding for disease and weather resistance with cabbage; comparison of California and home-grown seed of celery; seed selection, fertilizing, cold storage, and varieties of potatoes; rust-proof Rockymelons; poultry manure supplemented with phosphoric acid and potash for onions and tomatoes; variety tests of tomatoes and effect of copper solutions and other substances on disease resistance in tomatoes; and improvement and culture of various flowers, including carnations, geraniums, roses, and violets.

The work in the botanical and pathological department of the station included tests of the effect of various lime and sulphur sprays on different crops, especially the peach and plum, and of methods of preparing the sprays; tests of iron sulphate and other chemicals for killing weeds; classification of a collection of Maryland grasses; and collection of information on cause, prevalence, amount of injury, and treatment of economic plant diseases in Maryland. The chemical department carried on studies of the chemical and physical properties of unproductive soils.

In the dairy department experiments were completed and compiled for publication on the manufacture of sweet-cream butter, butter making in Maryland, and methods of whipping cream. Work was also undertaken on the sources of contamination of milk in the

barn as related to velocity and direction of the wind and humidity of the atmosphere.

The poultry work included tests of poultry houses to ascertain the type best adapted to the climate of Maryland and breeding of Barred Plymouth Rocks for egg production. Eggs from improved stock were distributed to a limited extent in the State, and an investigation of the poultry industry in Maryland was made during the year.^a

The activities of the veterinary department were confined principally to a study of the cow's udder with reference to milk production. Investigations on tuberculosis and bovovaccination were continued during the year, and a report on these subjects is being prepared. A study of the properties of fat cells in milk of different breeds was begun, and investigations on the relation of bacteria, leucocytes, and chemical changes in milk as affected by inflammation were continued.

In the entomological department experiments were made with spray mixtures and on the treatment of the codling moth, woolly aphis, green aphis, asparagus beetles, flea beetles, plum curculio, and peach-tree borer. Further experiments were made in the dipping of fruit trees, and in cooperation with the Bureau of Entomology of this Department an investigation of the bee-keeping industry of the State was begun. The state horticultural and nursery inspection work was done by the botanist and entomologist of the station, as in previous years. The members of the station staff also participated to some extent in farmers' institutes and other farmers' meetings.

The last legislature passed an act constituting the board of trustees of the college the state board of agriculture and making the director of the station the secretary of the board.

The following publications of the station were received during the year: Bulletins 126, Manuring and fertilizing truck crops; 127, Miscellaneous greenhouse notes; 128, The effect of animal digestion and fermentation of manures on the vitality of seeds; 129, Silos and silage in Maryland; 130, Nurseries and nursery inspection; 131, Miscellaneous treatment for San José scale; and 132, Irish potato investigations; and the Annual Report for 1908.

The income of the station during the past fiscal year was as follows:

United States appropriation, Hatch Act.....	\$15,000.00
United States appropriation, Adams Act.....	11,000.00
State appropriation	7,500.00
Balance from previous year, state appropriation.....	3,396.24
Farm products, including balance from previous year.....	4,745.86
Total	41,642.10

^a Maryland Sta. Bul. 138.

A report of the receipts and expenditures for the United States funds has been rendered in accordance with the schedules prescribed by this Department and has been approved.

With the aid of substantial support from the State, steady progress was made during the year at the Maryland Station in developing experimental work and in disseminating the practical results of the work among the farmers of the State.

MASSACHUSETTS.

Massachusetts Agricultural Experiment Station, Amherst.

Department of the Massachusetts Agricultural College.

W. P. BROOKS, Ph. D., *Director*.

But little change was made in the lines of work of the Massachusetts Station during this year and no new members were added to the station staff. C. S. Pomeroy, assistant horticulturist, resigned in October, and R. D. McLaurin at the close of the college year. The State made an appropriation of \$80,000 for a building for the departments of entomology and zoology, which is now in process of construction and is to be completed in 1910.

In all the various lines of investigation under the Adams fund satisfactory progress was made. The inquiry into the relation of plant-food elements to the characteristics and growth of asparagus was carried on cooperatively by the agricultural and chemical departments. Breeding asparagus for rust resistance is carried on in cooperation with the Bureau of Plant Industry of this Department. The investigation upon the principles underlying the fertilizing of the cranberry has made progress and a chemical study of the soils has also been undertaken. The department of botany is investigating the effects of meteorological conditions on plant growth and plant diseases. In the greenhouse these investigations concern the influence of light, moisture, heat, and ventilation on the growth of crops and their susceptibility to disease. In the outdoor work records are made of the time of blossoming, prevalence of diseases, earliness or lateness of crops, and the influence of climatic conditions on the plants during winter and summer.

The department of chemistry made successful progress in working out a method for the quantitative analysis of the different insoluble fatty acids of butter fat. Results secured with reference to the constitution of fats, and the effect of molasses on the digestibility of hay and other feeding stuffs, are being prepared for publication. Analyses of asparagus roots and of cranberry soils were made, and insecticides were studied in cooperation with the department of entomology. In addition to the latter, the department of entomology is pursuing work on the project relating to the digger wasps for

the purpose of learning the distribution, abundance, and individual work of these insects, and to determine their true economic value. Considerable advance has also been made in the study relative to the groups *Pyralidæ* and *Tortricidæ*, and the amount of damage caused by these little-known insects has been determined to some extent.

In addition to Adams fund work various lines of investigation were pursued by the different departments of the station. The agriculturist is carrying on extensive fertilizer experiments with field, orchard, and garden crops in order to determine their nitrogen, phosphoric acid, and potash requirements. The relative value of different substances as sources of the various fertilizing ingredients of various crops has been reported upon in part in the publications of the station.

The chemist cooperated with the agriculturist in the study of clover sickness and in addition conducted experiments for the purpose of noting the effect of different amounts of protein for profitable milk production, determining the best varieties of silage corn, and preparing a satisfactory grain ration suitable as a partial milk substitute for young calves.

The department of botany continued its studies of the diseases of a large number of plants, and made observations on the effect of spraying with different mixtures on the plants themselves as well as on the diseases to be combated. A bulletin on shade trees prepared in cooperation with the department of entomology and the Massachusetts Forestry Association was published during the year.

Among other work of the department of entomology, studies on wireworms in connection with seed corn were carried on, methods of controlling cabbage maggots and onion thrips were tested, the dates of hatching scale insects were observed, the importance of the second brood of the codling moth in Massachusetts was investigated, and efforts were made to discover and to work out the life history of an egg parasite of the asparagus beetle.

In horticulture the work was mainly along the line of plant breeding, but in addition variety tests, pruning experiments, and comparisons of orchard cover crops were carried on.

The veterinarian has been investigating the transmission of tuberculosis to calves by means of separator skim milk. He completed a study on the effect of arsenate of lead on stock allowed to graze under trees sprayed with this substance. The usual meteorological observations and records were continued.

The following publications were received from this station during the fiscal year: Bulletins 124, Bee diseases in Massachusetts; 125, Shade trees; 126, How to fight cranberry insects; 127, Inspection of commercial fertilizers; and 128, Inspection of commercial feeding

stuffs; Circulars 15, Cost of testing pure-bred cows; and 16, Seeding mowings; and Meteorological Bulletins 234-246.

The income of the station during the past fiscal year was as follows:

United States appropriation, Hatch Act-----	\$15,000. 00
United States appropriation, Adams Act-----	11,000. 00
State appropriation-----	13,500. 00
Balance from previous year, state appropriation-----	7,529. 52
Fees-----	5,210. 00
Farm products-----	2,387. 57
Miscellaneous-----	4,825. 17
Total-----	59,452. 26

A report of the receipts and expenditures for the United States funds has been rendered in accordance with the schedules prescribed by this Department and has been approved.

This station continues to cover a wide field of effort, which includes many subjects of special importance to the agriculture of the State. The growth of the college work will soon make additional provision necessary in some departments if the station work is to continue to develop.

MICHIGAN.

Experiment Station of Michigan State Agricultural College, East Lansing.

Department of Michigan State Agricultural College.

R. S. SHAW, B. S. A., *Director*.

During the year a number of changes were made in membership of the station staff and in the organization of the work at the Michigan Experiment Station. As a part of the extension reorganization of the agricultural work, divisions of animal husbandry, dairy husbandry, soils, and farm crops were established with H. W. Norton, A. C. Anderson, J. A. Jeffery, and the director in charge of these respective divisions. H. J. Eustace, expert in fruit storage in the Bureau of Plant Industry of this Department, was appointed horticulturist, L. R. Taft, consulting horticulturist, and Dr. W. J. Beal was reappointed botanist. Other recent appointments include the following assistants: M. A. Yothers, entomology; F. A. Spragg, farm crops; C. B. Collingwood, who resigned later in the year, chemistry; G. B. Schafer and Misses Z. Northrop and L. M. Smith, bacteriology; and J. B. Dandeno, botany. Other appointments were O. K. White as field agent in horticultural extension work, and A. R. Potts for similar work with soils and field crops; and C. S. Robinson as research chemist in place of S. L. Jodidi, who resigned to accept a similar position in the department of soils at the Iowa Station.

The construction of the new agricultural building, to be occupied by the station and the college, made good progress and when com-

pleted will afford better and more nearly adequate quarters for a number of the station departments.

The state legislature during this year enacted a law relative to seed inspection and the organization and conduct of this work was placed under the supervision of the director of the station.

The four Adams fund projects studied are each subdivided and assigned to certain investigators. Progress was reported on practically all the projects. Investigations on the bacterial factors determining the qualities of milk and butter were continued, and a second report on the keeping quality of butter was prepared. It was found that salted butter through leakage loses more water when stored than does unsalted butter, and the results further indicated that the quality decreases as the content of amid nitrogen increases. Some of the micro-organisms found in butter were observed to multiply slowly at -6° C. in salted butter.

The study of agents rendering available the insoluble elements of the soil is a cooperative undertaking. The soil physicist is studying the temperature relations and is attempting to perfect a new soil thermometer. The chemist is studying the soluble and insoluble phosphates of the soil, the assistant chemist the availability of the nitrogenous compounds in the soil, the assistant botanist the physiological effect of root excretions on plant growth, and studies are also in progress on the bacterial factors, with special reference to rendering soluble the insoluble phosphates. The results secured in studying the availability of the nitrogenous soil compounds were prepared for publication, and the results of the preliminary study of the agents rendering soluble the insoluble phosphates have appeared in bulletin form.

According to a preliminary report on the investigation of swine epidemics, it was demonstrated that the Dorset-Niles hyperimmunization process results in the production of agglutinins and immune bodies for *Bacillus cholerae suis*, but the nature of these immune bodies nor the constancy with which they occur has not as yet been determined. In connection with the hog-cholera investigations, the State has provided \$1,500 for the manufacture of serum, which is sold at the rate of 2 cents per cubic centimeter, 22 to 25 cubic centimeters being required for 100 pounds live weight of a hog.

The fourth project involves extensive investigations of the respiratory systems of insects, in a study of the method by which contact insecticides are effective. This project, which is pursued by the entomologist and a research assistant, also includes studies on fungus parasites of sawflies and other insects.

In addition to the Adams fund investigations, a large amount of work is carried on under the Hatch and other funds. In the department of animal husbandry, experiments with horses, cattle, and

sheep are in progress. The work with hogs was discontinued on account of disease. The third year's work on the production of baby beef was completed and the results are soon to be published. Two years' experiments in the economical wintering of work horses were finished, and a preliminary report suggests the use of a variety of cheap yet efficient feeds in place of oats and timothy hay. The third year's work with feeding succulents to sheep showed no particular advantage over feeding roots when the extra expense is considered. Breeding experiments with sheep and cattle were also carried on.

In the dairy department demonstration experiments were made of the value of well-bred dairy cows, the care of milk on the farm, and the production of sanitary milk. The third year's performance of the grade dairy herd was recorded. The poultryman completed the second year's trial of three types of poultry houses designed as models for farm use, and studied in addition the relative value of various feeds for young chicks and the relation of age and breeding of pullets to egg production.

The horticulturist conducted experiments in potato spraying, testing fertilizers for apple, peach, and grape growing, comparing sucker and pruning wood of apples for propagation, soil sterilization of greenhouses, peach pits as a means of disseminating disease, lime and sulphur as a summer spray, and cover crops for vineyards in conjunction with commercial fertilizers.

Plant breeding and culture experiments were in progress with practically all the important crops. The improved strains developed in this work were tested throughout the State in cooperation with the recently established Experimental Union.

The extension work is organized and managed under state appropriations and during the year 3 men were constantly maintained by the college for giving instruction and demonstrations in live-stock management, horticulture, and field crops. The Experimental Union, comprising over 200 members, engaged in cooperative work in crop testing and soil studies. During the year, 872 bacterial cultures for leguminous crops were sent out to farmers from the bacteriological department, which also furnished virus and serum for immunizing over 2,000 hogs. In the extension work in animal husbandry efforts were directed mainly toward the organization of cooperative breeders' associations, and during the first six months of the year ten associations were formed representing 2,100 cows, and 51 registered sires were purchased.

The publications of the station received during the year were as follows: Bulletins 251, Insects of 1907; 252, Fertilizer analyses; 253, Can the general farmer afford to grow apples; and suggestions on improving and spraying apple orchards; Special Bulletins 42,

Bacterial associations in the souring of milk; 43, The solvent action of soil bacteria upon the soluble phosphates of raw bone meal and natural raw rock phosphate; 45, Spraying calendar; 46, Report of the South Haven Substation for 1907; 47, Corn improvement; and 48, Report of the South Haven Substation for 1908; Circulars 1, Alfalfa; 2, The Babcock test; 3, Corn: Selection, storing, curing, and testing for seed; 4, Methods of breeding for the improvement of Michigan cattle. Organization of cooperative cattle breeders' associations in Michigan; and 5, Inoculation with nodule-forming bacteria; and the Annual Report for 1908.

The income of the station during the past fiscal year was as follows:

United States appropriation, Hatch Act-----	\$15,000.00
United States appropriation, Adams Act-----	11,000.00
State appropriation-----	14,148.10
Fertilizer, licenses, fees-----	3,802.50
Farm products, including substations, etc-----	1,266.76
Total-----	45,217.36

A report of the receipts and expenditures for the United States funds has been rendered in accordance with the schedules prescribed by this Department and has been approved.

With the aid of the state funds, which are appropriated in part for the maintenance of substations and in part for experiments along special lines, and with the further assistance of a well organized extension department in the college, the Michigan Station is placed in favorable circumstances for accomplishing much of fundamental importance and practical value to the different agricultural pursuits of the State.

MINNESOTA.

Agricultural Experiment Station of the University of Minnesota,

University Farm, St. Paul.

Department of the University of Minnesota.

A. F. Woods, M. A., *Director.*

A number of changes took place in the station staff during the year, the principal one being the appointment of J. W. Olsen, state superintendent of public instruction as dean and director, following the resignation of E. W. Randall, who entered commercial life. Since the close of the fiscal year J. W. Olsen also resigned and has been succeeded by A. F. Woods, assistant chief of the Bureau of Plant Industry of this Department. During the year numerous changes also occurred in the corps of assistants.

State appropriations of interest to the station were made by the last legislature as follows: \$15,000 for the completion and equipment

of the dairy pavilion, \$15,000 for remodeling and equipping the dairy hall, \$10,000 for hog-cholera work, \$6,000 for a denatured alcohol plant, \$1,000 for soil inspection, \$4,000 for live stock, \$6,000 for horticultural investigations, \$1,000 for entomological investigations, \$3,500 for the breeding of field crops, \$1,500 a year for two years for experiments in the use of preservatives for timber, \$5,000 for the purchase of lands for forestry experiments at Cloquet, \$2,500 per year for maintenance of a forestry experiment station at Cloquet, \$2,000 for drainage studies, \$400 for work on plant diseases, \$1,000 for the study of noxious weeds, \$1,000 for alterations in the veterinary building, \$10,000 for the establishment and maintenance of a poultry department, and \$100,000 for an engineering building for the department of agriculture.

A farm has been leased for five years to carry on experiments in quack grass eradication. Twelve demonstration farms of 80 acres each have been established throughout the State and more recently plans were made for seven similar farms in addition. Since the close of the fiscal year the post-office address of the college and station has been changed to University Farm, St. Paul.

Marked progress attended the work of the year on all the Adams fund projects. The investigations of the horticultural department were along the line of plant breeding and were carried on in connection with the general plant breeding work largely followed at the state fruit-breeding farm. In connection with this work, plantings of orchard and small fruits are becoming well established and considerable work is carried on in the greenhouses. The entomologist, in addition to the life history studies of *Empoasca mali*, *Macrosiphum granaria*, and *Brucophagus funebris*, continued the investigation of the cabbage maggot. This work has been reported upon in part in a bulletin of the station.^a In the beef production project, calves of different types and breeds are grown from birth to maturity for comparative slaughter tests and chemical analyses of the carcasses. The cereal breeding project is essentially a study of rust resistance in wheat, oats, and other small grains, carried on by the botanist and plant pathologist in the field and in the greenhouse. The problems included are the wintering of rust, the effects of red rust, and some anatomical features such as the correlation between the structure of the leaf and stem of plants and rust. A field laboratory method has been developed to induce a local and controllable rust epidemic. In connection with this investigation many selections and crosses of wheat have been made. In the work on the food requirements for milk and meat production, particular stress is now laid on meat production and records are made for beef animals as were made for dairy

^a Minnesota Sta. Bul. 112.

animals heretofore. The investigation of stable ventilation was continued with improved equipment.

In addition to the Adams fund work, numerous other investigations were carried on by the different departments of the station. The agriculturist worked on the origination of varieties of cereals and forage plants by selection and hybridization and of disease-resistant strains by selection from disease infected plants. Observations were made to determine the time required for varieties to come true to type. The study of the effect of rotations and of single crops on the fertility of soil started in 1894 was continued as was also the work on the cost of crop production begun in 1902.

The division of chemistry studied the manufacture of denatured alcohol and of the economy of the use of heat in the preparation of foods.

The division of agricultural engineering and physics, officially organized August 1, 1908, planned and supervised the construction of underdrains at the state fruit farm, made plans for the drainage of the Northeast Experiment Farm at Grand Rapids, conducted an irrigation experiment in cooperation with this Office, and gave assistance to drainage improvements throughout the State. The gratifying support given this new division by the State will soon enable it to broaden the scope of its work.

The work in animal husbandry consisted of feeding trials of sheep and swine and investigations in beef production. The dairy division completed experiments in feeding for milk production, in which gravimetric analyses of milkings and periodical analyses of all feeding stuffs consumed were made. The entomologist conducted experiments to determine the least number of sprayings with arsenate of lead upon plums to control the ravages of the plum curculio and to determine the possibility of poisoning fruit trees by the usual process of arsenical sprayings used by orchardists. Among other work scientific and economic studies were made of the genus *Papaipema*, or stalk borer.

The division of horticulture and forestry carried on variety, fertilizer, spraying, and breeding experiments with potatoes in addition to crossing experiments with plums, strawberries, raspberries, blackberries, and the treatment of conifer seed for the prevention of the damping off disease. Little advantage was derived from the use of fungicides for the prevention of late blight in potatoes at the station. The fruit breeding work of the station has aroused great interest. Private parties have taken up the work and a number of promising new varieties of fruits have been originated. While there has been no increase in the funds available for horticultural work, the State made a larger appropriation for experimental work in connection with forestry and it is now planned to establish an experi-

mental forest of 2,700 acres in the vicinity of Cloquet, Minn. Different rotation periods will be tried and an arboretum and forest garden established.

The soil work of the station was continued along the lines previously outlined. The chemical and physical properties of the various soil areas of the State were studied and fertilizer tests were made in different sections to study the relation between laboratory and field methods of determining the deficiency of fertilizing elements.

The division of vegetable pathology and botany occupied itself chiefly with diseases of plants, botanical features of weeds, and the study of weed seeds and seed mixtures. In addition to studying rusts and smuts of cereals, spikelet blights of oats, aster blight, damping off of greenhouse plants and coniferous seedlings, diseases of apples and plums, and bean anthracnose were given attention. Collections of various weed seeds growing in the State were made and the equipment of an up-to-date seed laboratory was about completed.

In the veterinary division the principal lines of work were with hog-cholera vaccine, swamp fever, and antituberculosis vaccine. In connection with the vaccine work results valuable from a scientific and practical standpoint were secured, and much information was gained on the nature of swamp fever. The latter was studied in cooperation with the pathological division of the Bureau of Animal Industry of this Department, under a special contract and a special appropriation of \$5,000. The work in this department has been considerably strengthened since the completion of the new veterinary building, providing much better facilities than were enjoyed previously. Cement cremation pits were constructed for the destruction of manure from diseased animals.

Among other work the substation at Grand Rapids cooperated with the Wisconsin Station in experiments as to the methods and cost of stump removal on cut-over lands.

The cooperative work of the station was carried on with farmers in corn-breeding investigations, studies of clover-seed culture, animal breeding, particularly with Shorthorn cattle, spraying trials, and preservation of fence posts; while with this Department this work was carried on along the lines of plant and animal breeding, preservative wood treatment, cereal diseases, particularly the rusts and smuts, and the swamp fever work already mentioned.

At the school of agriculture at Crookston, the experimental field work has thus far been preliminary. The farm was drained and put in much better condition than formerly. The live stock includes a number of Shorthorn and Holstein cattle, and a good poultry plant has been established with a large flock of Leghorns and Plymouth Rock fowls, of which egg records are kept. Much attention was

given to experiments with tile and open drains, and the effect of this work on the drainage of the region in the vicinity has already become marked.

The following publications of the station were received by the Office during the year: Bulletins 109, The rotation of crops; 110, Installation of an experimental drainage system; 111, Flour bleaching; 112, The apple leaf hopper and other injurious insects of 1907-8; 113, Hog cholera and hog-cholera vaccine; 114, Potato experiments and studies at University Farm. Potato growing in Minnesota; and 115, Seed grain.

The income of the station during the past fiscal year was as follows:

United States appropriation, Hatch Act.....	\$15,000.06
United States appropriation, Adams Act	10,930.09
Balance from previous year, Adams Act.....	69.91
State appropriation, including substations.....	59,194.12
Farm products, including substations.....	13,380.28
Total.....	98,574.40

A report of the receipts and expenditures for the United States funds has been rendered in accordance with the schedules prescribed by this Department and has been approved.

The work of the Minnesota Station has continued to broaden in scope, to be strengthened by improvements in equipment, and to receive recognition of its merit by the gratifying and liberal support given the institution by the farmers and the State.

MISSISSIPPI.

Mississippi Agricultural Experiment Station, *Agricultural College.*^a

Department of Mississippi Agricultural and Mechanical College.

W. L. HUTCHINSON, M. S., *Director.*

Several changes in the personnel of the station occurred during the year, and an effort was made to separate the station from the teaching force, or at least to require less teaching of station men. J. Lewis was appointed veterinarian and A. B. McKay was reelected horticulturist. W. R. Perkins was relieved of all college work in order that he might give his time to the station. R. W. Harned was elected entomologist and S. F. Blumenfeld his assistant. On July 1, 1908, the college turned over to the station the entire farm except the part used by the dairy. A new administration building has been completed by the college at a cost of \$100,000 in which the administrative offices of the station will be accommodated.

^a Telegraph address, *Starkville*; express and post-office address, *Agricultural College*; freight address, *A. and M. College Station.*

In the Adams fund work, the mule breeding project was the largest undertaking, and this made quite satisfactory progress. A considerable number of mule colts are on hand, and records including measurements and photographs at different stages of growth are made. With the land at the disposal of the station at present it is planned to grow practically all the feed required in connection with this project.

The investigation of the physiological effects of cotton-seed meal included studies with cattle and hogs. Observations were made on the milk and blood of cows, their physical condition, fertility, condition of offspring, etc., and also on the blood of calves, hogs, and beef cattle. In some of these tests as high as 5 pounds of cotton-seed meal a day are being fed.

Several entomological projects were also continued, although somewhat interrupted by a change of leader.

The Hatch fund work included principally feeding experiments with pigs and steers, fertilizer and culture tests, and breeding investigations with field crops and insect studies. Experiments were conducted to test the effect on the progeny of wide, medium, and narrow rations fed to sows. Comparisons were made of yearling and 2-year-old steers fed on cotton-seed meal and hulls.

In agronomy the crops given most attention were corn and cotton, but soy beans and other forage crops were also studied. In view of the coming of the boll weevil the work with field crops is pursued with the purpose of being able to discount the ravages of this pest to the best advantage.

In dairy husbandry, comparison of various home-grown and purchased feeds was made and a record of the herd was kept.

The entomologist pursued work on the pine twig borer and the pine sawfly.

In forestry some work was done with galled land in growing fence posts.

In the poultry department the work was much as in previous years—mainly commercial and educational and for the encouragement of poultry raising in the State. There was very little work of an experimental nature.

The affairs at the branch stations progressed in a satisfactory manner. Dairy barns with a capacity of about 30 cows were built at the McNeill and Holly Springs stations. The Delta Station, in addition to its work with farm crops, gave attention to hog raising and published its results.^a Two institute trains were run over a very large part of the railroad mileage in the State, and station men and station results were the principal factors in making this feature successful.

^a Mississippi Sta. Bul. 107.

The publications of the station received during the year were as follows: Bulletins 110, Report of the work at the Holly Springs Station for 1907; 111, Experiments in feeding dairy cows; 112, Silage *v.* hulls and meal; 113, Cotton experiments, 1907; 114, Inspection and analyses of cotton-seed meal on sale in Mississippi; 115, Inspection and analyses of commercial fertilizers on sale in the State; 116, Varieties of cotton, 1908; 117, Cotton culture in Mississippi; 118, Clearing pine lands; 119, Report of the work at the Delta Station for 1907-8; 120, Farmers' institute bulletin 1907-8; 107 (rev.), Pork production at the Delta Station; Circulars, June, 1908, The insect pest law; 25, Inspection and analyses of commercial fertilizers on sale in the State; 26, Inspection and analyses of commercial fertilizers on sale in the State; 27, Inspection and analyses of commercial fertilizers on sale in the State; 28, Inspection and analyses of commercial fertilizers on sale in the State; 29, Inspection and analyses of commercial fertilizers on sale in the State; and Annual Reports for 1906, 1907, and 1908.

The income of the station during the past fiscal year was as follows:

United States appropriation, Hatch Act.....	\$15, 000. 00
United States appropriation, Adams Act.....	11, 000. 00
State appropriation for substations.....	19, 150. 00
Farm products, including substations.....	13, 907. 90
Fees	130. 00
Miscellaneous, including substations.....	4, 398. 49
Total.....	63, 586. 39

A report of the receipts and expenditures for the United States funds has been rendered in accordance with the schedules prescribed by this Department and has been approved.

The work of the Mississippi Station has been affected by changes in personnel and by the transfer to it of responsibility for the college farm of about two thousand acres. A result has been the carrying on of large commercial operations which have been a drain on the time of the station men. There should be a more definite segregation of the farm operations, even when they are connected with the growing of feed for station animals, and an arrangement for the management of such operations which will relieve the men in charge of experimental work. In some lines, notably the poultry department, the condition as to experimental work has been unsatisfactory, and in other directions the experimental work needs to be strengthened and put upon a more active and efficient basis.

The extension work in the State is organized as a separate branch, the three substations are doing an important work for their respective localities, and the opportunity for aggressive and high-class work at the main station along a number of advanced lines should be excellent.

MISSOURI.

Missouri Agricultural College Experiment Station, *Columbia*.

Department of the College of Agriculture and Mechanic Arts of the University of Missouri.

F. B. MUMFORD, B. S., *Director*.

Numerous important changes occurred in the personnel of the station during the year, the principal one being a change of director. Director H. J. Waters resigned to accept the presidency of the Kansas Agricultural College, and F. B. Mumford was elected dean of the college of agriculture and director of the experiment station. E. A. Trowbridge was promoted to be assistant in animal husbandry, and J. M. Stedman, the entomologist, resigned to become assistant farmers' institute specialist in this Office. J. R. Keithley, assistant in dairy husbandry, who accepted a position in the dairy division of this Department, was succeeded by R. E. Hundertmark. O. E. Reed, assistant in dairy husbandry, resigned to become instructor in milk production at Purdue University, and H. E. McNatt was appointed to fill the vacancy. The position of animal husbandman, which became vacant by the resignation of C. W. Rine, was filled by the appointment of R. J. Carr. D. H. Doane, as special agent, was placed in charge of the Missouri district of the farm management investigations under this Department, in cooperation with the station. L. Haseman, assistant entomologist, resigned to take up graduate work at Cornell University. Other appointments included the following assistants: C. T. Dearing, horticulture; C. A. Schwartz, botany; J. B. Latshawe, veterinary science; A. A. Jones, agricultural chemistry; E. W. Rusk, animal husbandry; F. W. Woodman, research chemistry; and C. K. Francis, research agricultural chemistry. F. S. Putney was appointed assistant to the dean and director, vice J. M. Evvard, who was appointed assistant in animal husbandry, vice H. P. Rusk, resigned.

The new agricultural building was occupied about September 1. This affords adequate quarters for the administrative offices and the library of the station, and provides laboratory room for a number of the departments. The cold-storage and ice-making plant has been installed and has already been used extensively in the experimental work with meats and dairy products.

The Adams fund work under way remained unchanged so far as the projects are concerned. The dormant period of trees in a large number of species has been found to vary greatly in length, some Japanese varieties hardly resting at all. In this connection the amount of moisture and the individuality seemed to be important factors. The study of the relation of nourishment of fruit trees to

their resistance to disease was carried on in eight apple and five peach orchards in different places, and is resulting in a large amount of data. The breeding of peaches to eliminate the purple coloring matter in the twigs was actively pursued, with interesting results.

In the study of the possibility of immunizing hogs against cholera and swine plague, special attention was given to improvement in the preparation and the utilization of serum. The strictly Adams fund work was combined with practical attempts to control hog cholera, in cooperation with the State Board of Agriculture, and recent efforts to inoculate hogs with serum on a large scale have met with good success.

The work on the nutrition of heifers during their growing period in relation to their subsequent functional activities, size, vigor, and general usefulness, carried on by the department of dairy husbandry, is an extensive and thorough investigation in which a very large amount of data is accumulating. The study of the factors affecting the chemical and physical properties of milk, carried on by the same department, has been in progress for nearly three years and involves a large amount of chemical and physical examination.

The programme of work conducted with Hatch funds is also quite heavy, and a large amount of data is on hand awaiting publication. Feeding experiments carried on by the department of animal husbandry appeared to point out that the condition of the animal when feeding begins is more important than its age as far as economic gains are concerned. The cost of feeding stuffs used supplementary to corn was greater than the cost of corn with only one exception in seven years, during which time 500 animals were under experiment. Feeding tests with hogs and horses followed in addition to the experiments mentioned. Several lines of breeding work are pursued with different kinds of farm animals. Observations made in connection with mule breeding show that telegony is not so prevalent as has been supposed. The effects of breeding immature parents in hogs and inbreeding of hogs and sheep were also studied.

The department of agronomy is pursuing rotation experiments which have gone on for twenty years, in which the effect of the different rotations on the humus content of the soil is being observed. Culture tests and plant-breeding experiments are followed with a number of crops, but mainly with wheat, oats, and corn. In the work with corn, attention is being paid to the relation of leaf surface to yield and to the cause of barrenness. Field experiments are made in different parts of the State in cooperation with the soil survey. The outcome of about 50 cooperative experiments on alfalfa is that in about two-thirds of the cases inoculation was found beneficial. There are now, 92 cooperative experimental fields in 114 counties of the State. Under the state law, county farms may be used for experi-

mental purposes with the arrangement that the county is to bear the expense and the station to furnish the supervision and to publish the results. So far only the farm in Jasper County is being used.

The horticultural department is pursuing apple breeding with special reference to the use of self-fertilized versus cross-fertilized seedlings. Apples were also grown on different stocks and, among other work, experiments were carried on with asparagus, tomatoes, and strawberries. The spraying work of the department included demonstration and local tests in addition to spraying cherries in combating leaf spot.

The dairy department is doing preliminary work in the determination of the effect of feed on the composition of milk, and has in progress an experiment to ascertain the causes of wide variations in economy of milk production by different cows. A comparison of the nutrients required for the production of butter fat and body fat in the same animal and a study of the factors regarding development of dairy cattle are also under way.

A soil survey of the State based on geological strata and including chemical and physical examinations of the different types of soil is being conducted, partly in cooperation with the Bureau of Soils of this Department. For this work the State has appropriated \$15,000 of which \$4,000 became available this year.

The members of the station staff did considerable extension work and frequently officiated as judges of corn and live stock at county and state fairs. The State appropriated \$10,000 each for the erection of a veterinary hospital, the manufacture of hog-cholera serum, furnishing of the new agricultural building, and for the heating plant for the agricultural building.

The following publications of the station were received during the year: Bulletins 80 and 82, Inspection of commercial fertilizers; Circulars of information 22, Feeding the orchard; 23, Fungicides, insecticides, and spray calendar; 24, Beef production on high-priced land; 25, Rational sheep feeding; 26, Feeding the dairy cow; 27, Feeding and care of horses; 28, Swine feeding; 29, Immunization of swine against hog cholera; and 30, Missouri housekeepers' conference association.

The income of the station during the past fiscal year was as follows:

United States appropriation, Hatch Act-----	\$15,000.00
United States appropriation, Adams Act-----	11,000.00
State appropriation -----	1,473.87
Balance from previous year, state appropriation-----	2,974.37
Fees -----	7,643.17
Sales, including balance from previous year-----	4,457.90
Total -----	42,549.31

A report of the receipts and expenditures for the United States funds has been rendered in accordance with the schedules prescribed by this Department and has been approved.

The Missouri Station is doing an important work for the agriculture of the State. The latter has contributed generously to its support, and this has enabled it to conduct lines of investigation which are fundamental and of much scientific and practical interest.

Missouri State Fruit Experiment Station, Mountain Grove.

PAUL EVANS, *Director*.

As in previous years, the attention of this station was mainly devoted to studying the insects and plant diseases affecting fruit. Considerable work was done in the line of spraying apples for curculio and codling moth, and different kinds of sprays were compared in this connection. Attention was also given to other methods of control. The station owns a very complete line of spraying machinery and has made it a point to assist fruit growers and orchardists with advice regarding the use of such machines and the construction of devices to facilitate spraying work in general.

In cooperation with the Bureau of Entomology of this Department, the comparative efficiency of spraying and dusting was studied. The results of one year's test conducted under adverse conditions did not seem to warrant the use of dust in apple orchards. Studies were also made of the scale insects of Missouri orchard fruits and particular attention was given to the San José scale.

The plant pathologist made progress in his studies of the various fungus diseases common to the cultivated fruits of the Ozark region. A descriptive list of the principal fruit diseases with directions for their control has been published by the station.

The following publications were received from the station during the year: Bulletins 16, Fruit tree diseases and fungicides; 18, Scale insects of the orchards of Missouri; 19, Spraying *v.* dusting; 20, Spraying machinery; and 21, Spraying apples for curculio and the codling moth.

The station is maintained by a state appropriation of \$33,600 for the biennium ending December 1, 1910.

MONTANA.

Montana Agricultural Experiment Station, Bozeman.

Department of the Montana College of Agriculture and Mechanic Arts.

F. B. LINFIELD, B. S. A., *Director*.

The Montana Station and College continued to develop along the different lines of their activities and to be favored by state assistance.

For the current biennium the station was given a state appropriation of \$12,500 per year for maintenance, an increase of \$5,000 per year, in addition to a like amount for the maintenance of the substations. For improvements \$10,000 was granted for a sheep and steer barn in addition to the poultry plant and sheds for young stock, together with \$8,000 for the substations. E. L. Tannatt, engineer in the station, and W. R. Fisher, horticulturist, resigned to engage in commercial work, the resignations taking effect at the close of the year. E. Burke, assistant chemist and meteorologist, was appointed chemist and R. M. Pinckney was appointed assistant chemist.

Good progress was made on all the Adams fund projects in hand. Thus far the results secured in the project on the formation of nitrates seem to show that no relation exists between nitrate content and cultivation on irrigated land, while under dry-farming conditions cultivation does affect the nitrate content of the soil. Data in the soil moisture project seemed to indicate definite effects of fallow, cultivation, and cropping on the depth of the moisture area and the movement of moisture in the soil. The investigation on the incubation of eggs has shown that no material increase in the temperature of the top of the egg takes place as incubation proceeds, while the temperature of the bottom increases a number of degrees. It also has been definitely determined that the hen gives off considerable moisture and carbon dioxid when hatching.

Considerable work was done on the disintegration of Portland cement, and a bulletin reporting this work has been issued.^a The chemical changes taking place when cement is acted on by alkali were determined as the cause of disintegration, and the work has now been extended to the protection of cement structures from this action. Results secured in connection with the wool project indicate that great differences are found in the strength of the fiber from different parts of the animal. The work on the arsenical compound project was essentially a physiological study of the character and amount of injury to trees.

Definite progress on the project relating to the diseases affecting the wood or bark of orchard trees is also reported. The entomologist worked out species and determined life histories and other data of sugar-beet insects. Work was also begun on a new project regarding the control of the oyster-shell scale. Experiments thus far made show that where sulphur remains on the trees the insects are destroyed.

The experiments under the Hatch Act are also put upon a project basis. The work in agricultural engineering was transferred to the

^a Montana Sta. Bul. 69.

department of agronomy, which is also carrying on variety, culture, rotation, and irrigation tests with various crops, making plant hybrid and individual plant selections, and testing the moisture conserving efficiency of mulches. Several lines of investigation are carried on in cooperation with this Department.

A 3-year test and record of the milking machine made by the dairy department indicated that under certain conditions the machine may be economically and successfully operated. This Department also studies the effect on calves fed on milk treated with formaldehyde, the effect of acidity on character and content of germs in milk and on digestibility, and the effect of age of cream on the melting point of butter as related to the use of the hand separator.

The department of chemistry made experiments with reference to the treatment of alkali soils, buffalo wallows, and gumbo soils, together with pot experiments on the use of gypsum either alone or with manure and lime.

In animal husbandry the experiments in beef production were continued, different amounts of corn being fed with reference to the profitable length of the feeding period, the degree of ripeness in relation to shipping, the finish obtained with different feeds as related to percentage of dressed meat, and like factors. The data on some 20 experiments with pigs fed on grain and forage were ready for publication, as was also a bulletin on the feeding of different amounts of grain to steers.

The work of the botanist included studies on plum pocket, poplar canker, poplar blight, and potato dry rot. The station entomologist acts as state entomologist and in this connection secures much material for miscellaneous studies under this fund.

The horticulturist at the time of his resignation had prepared a bulletin on apple growing in Montana and on experiments with ornamentals, and had on hand material for a bulletin on vegetables. The horticultural work is largely carried on at the substation in the Bitter Root Valley.

W. J. Taylor was placed in charge of the department of veterinary medicine, but his work will be largely for the college.

The station is carrying on cooperative work with this Department along the line of crop rotations, varietal tests of grains and forage crops, and methods of crop management for dry farming conditions, the water losses from irrigated land with various depths of mulches or without mulch, the life history of the tick and its relation to spotted fever, and with the principal railroads of the State in connection with 11 substations, essentially demonstration farms, for the study of dry farming conditions.

The farmers' institute work of the station consists in work connected with meetings on the demonstration farms to call attention

to the results of the various methods of soil and crop management, and in attendance on farmers' institutes for about 2 or 3 weeks during the year.

Nine bulletins and the Annual Reports for 1907 and 1908 have been received from this station during the past year. The bulletins were as follows: Bulletins 68, Canadian field peas; 69, The effect of alkali on Portland cement; 70, The Douglas spruce cone moth; 71, Fifth annual report of the state entomologist of Montana; 72, Measurement of water; 73, Pig feeding experiments; 74, Dry farming investigations in Montana; 75, Sixth annual report of the state entomologist of Montana; and 76, Seepage and drainage.

The income of the station during the past fiscal year was as follows:

United States appropriation, Hatch Act.....	\$15,000.00
United States appropriation, Adams Act.....	10,999.96
Balance from previous year, Adams Act.....	.04
State appropriation.....	10,712.99
Individuals	4,561.49
Farm products	5,090.27
Total.....	46,364.75

A report of the receipts and expenditures for the United States funds has been rendered in accordance with the schedules prescribed by this Department and has been approved.

The Montana Station gives evidences of substantial progress, and the work which the station is doing in dry farming has greatly increased its influence in the State.

NEBRASKA.

Agricultural Experiment Station of Nebraska, *Lincoln*.

Department of the University of Nebraska.

E. A. BURNETT, B. S., *Director*.

The past year at the Nebraska Station was again marked by extensive improvements made possible through state aid. The veterinary clinic building was erected at a cost of \$12,500, and \$8,000 was expended on road construction and the improvement of the farm campus. Since the close of the fiscal year an independent water plant has been established at a cost of \$5,100. The state legislature made an appropriation of \$4,500 for substations, and \$100,000 for permanent improvements, the purchase of additional land, and other purposes. For the suppression of plant diseases \$6,000 per year was allowed for the current biennium, and for the same period \$12,500 annually was granted for the substation at North Platte. Fifteen thousand dollars was given for the purchase and the maintenance for 1909-1911 of a second substation in the north and northwest portion of the State. Five thousand dollars was appropriated to supplement work of the

United States Department of Agriculture for irrigation and dry farming under the North Platte reclamation project. The supplemental report shows that at the Central Station \$29,000 was expended outside of Hatch and Adams funds.

The principal change in the personnel of the station was caused by the resignation of Dr. A. T. Peters, who is now in charge of the Illinois State Biological Laboratory. J. H. Gain was promoted to the head of the department of pathology and veterinary science. E. A. Burnett, associate dean in the industrial college, was made dean of the college of agriculture, a position established under a recent reorganization of the university. A number of changes also took place in the corps of assistants.

The work on the Adams fund projects during the year was progressive and productive of results. A large amount of data were secured in studying the problem whether corn uses up the soil moisture according to the weight or leaf area of the plant. The results for the year are of special interest on account of the injury to the corn crop in that region by drought. In observing the effect of thickness of stand, it was found that in thickly planted wheat and oats about 50 per cent of the young plants are eliminated. In the case of corn the greatest average yield has so far been from the thick planting.

A study on the close breeding of maize to determine whether it is advantageous to increase corn indefinitely from the single ear was systematically pursued and a considerable amount of data obtained. Observations in regard to the effect of soil moisture on the winter injury of fruit trees indicated a definite relation between these two factors. A temperature of -9° C. killed all the seedlings regardless of moisture. The study of heredity in plants has brought out many points of interest and of value. Work was also continued on the project of tuberculosis in swine, and in an effort to find a practical test for the disease, the precipitate method was tried. Progress in the study of plant diseases is reported in the twenty-second annual report.

The study of laboratory methods for determining humus was completed, and the investigations on the strength of bone as affected by feeds were continued. Results recently reported^a seem to indicate that foods rich in phosphates and mineral matter strengthen the bones. An investigation of swamp fever is also in progress, and efforts were made to determine the rôle of flies in spreading this disease.

Progress is further reported in numerous lines of work carried on under the Hatch Act. The work of the horticultural department included a study of different methods of culture on orchard plats, a

^a Nebraska Sta. Bul. 107.

comparison of mulching and cultivation in potato culture, and breeding work with the apple and peach. Considerable demonstration work in orchard spraying was done with state funds. The department of soil agronomy made moisture determinations in the station fields and tested the growth and use of sweet clover in corn fields.

The department of agronomy continued its work on wheat improvement. Thus far the data secured seem to show that protein content is not inherited, but some families were found to have a higher average of protein, and some selected strains showed a higher protein content. This work also includes an effort to improve the methods of breeding.

The department of entomology built a new insectary, which makes a larger amount of winter work possible, and pursued special studies on the melon aphid, strawberry leaf-roller, squash-vine borer, and a grass scale injuring hay fields.

The work in animal husbandry is very largely a continuation of previous enterprises. Results seem to show that at present prices, linseed meal and cotton-seed meal for fattening cattle are of about equal value, and that cotton-seed meal made by a new process is quite satisfactory. Good results were also obtained by making a ration of half roughage and alfalfa without a concentrate for 2-year-old steers.

Experimental work in forestry is carried on at Lincoln and other places and has reference mainly to varieties, rate of growth, soil conditions, effect of different spacing, fertilizers, and similar problems.

The general plan of work at the North Platte substation was about the same as heretofore, including tests of varieties, crop rotations, soil moisture studies, experiments in forestry, orchard, and ornamental plants, the wintering of cattle on different kinds of roughage, feeding hogs on different grains, and the use of alfalfa for pasturage or hay.

The station cooperates with this Department in seed testing, wheat breeding, and hog cholera investigations, in observations on rotations and tillage on the crop production, and in forest planting at the substation at North Platte. With farmers, cooperation is carried on with orchard spraying demonstrations, testing varieties of corn and small grains, determining the effect of different fertilizers on grain production on impoverished land, and in studying farm management. Station workers cooperate with the farmers' institute department, which is supported by an annual state appropriation of \$10,000.

The publications of the station received during the year were as follows: Bulletins 107, Foods supplementary to corn in fattening pigs. The effect of food on breaking strength of bones; 108, Milk-

ing machines; and 109, Corn production in western Nebraska. Principles of cultivation; and the Annual Report for 1907.

The income of the station during the past fiscal year was as follows:

United States appropriation, Hatch Act.....	\$15,000.00
United States appropriation, Adams Act.....	11,000.00
Farm products	23,831.54
Balance from previous year, farm products.....	6,858.58
Total	56,690.12

A report of the receipts and expenditures for the United States funds has been rendered in accordance with the schedules prescribed by this Department and has been approved.

As in previous years, the Nebraska Station advanced in improvement of facilities and equipment and broadened the field of its work. The station continues to increase in popular appreciation and to receive gratifying financial assistance from the State.

NEVADA.

Nevada Agricultural Experiment Station, Reno.

Department of Nevada State University.

J. E. STUBBS, D. D., LL. D., *Director*.

Progress was made during the year in differentiating college and station work, relieving station men of college duties, and providing improved quarters and equipment for the station. An insectary was completed during the year, and a small building was constructed on a ranch about 20 miles south of Elko and equipped for laboratory work on animal diseases (Pl. VI, fig. 1). Shortly after the close of the year C. A. Jacobson, of the Rockefeller Institute, was added to the station staff as research chemist, and A. A. Heller was appointed assistant botanist and horticulturist during the year.

The last legislature appropriated \$10,000 for the purchase of a farm in the northeastern part of the State for dry-farming experiments, and during the year a tract of 160 acres was selected in the northern part of Elko County. The management of this farm was intrusted to the board of control of the experiment station. The station continues to participate in the management of the Lincoln County Experiment Farm in southern Nevada, being represented on the board of control of this farm by P. B. Kennedy of the station staff.

In accordance with the terms of a state pure food and drugs act, approved March 13, 1909, the work of inspection is placed in the hands of the director and chemist of the station. S. C. Dinsmore, junior chemist of the station, will have immediate charge of the work, for which an appropriation of \$6,000 for two years is provided.



FIG. 1.—FIELD LABORATORY OF NEVADA STATION FOR STUDYING EQUINE ANEMIA.

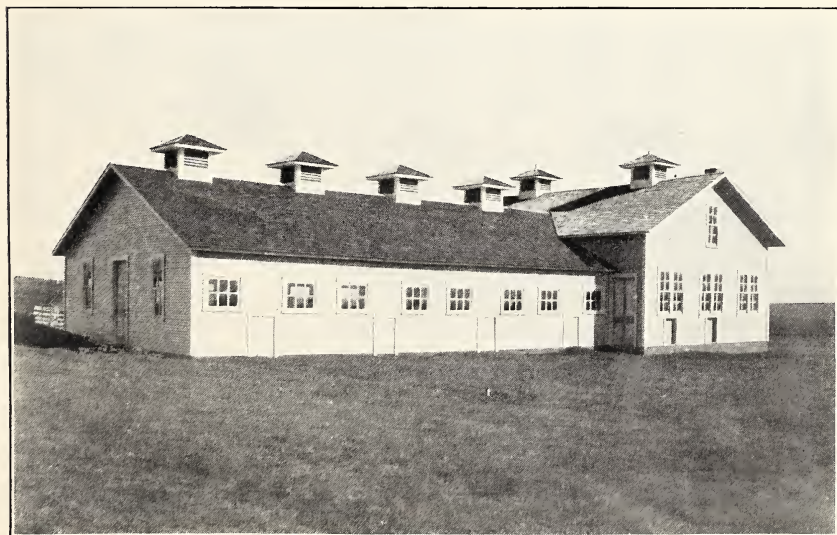


FIG. 2.—NEW HOG BARN AT THE OKLAHOMA STATION.

Another act of the last legislature provided for the establishment of a state hygienic laboratory to be located at the university. W. B. Mack, veterinarian and bacteriologist of the station, was placed in charge of this work, for which an appropriation of \$8,000 for two years was made.

Investigations were actively prosecuted during the year with the Adams fund on breeding of alfalfa, monographing the genus *Trifolium*, equine anemia, and meteorological and climatological studies on Mount Rose, and marked progress was made in all of these projects. Preliminary reports on equine anemia and on progress in the observations on Mount Rose, 1906-7, have been published.^a In connection with the project relating to the influence of soluble salts in the soil in relation to native plant growth, a large number of samples of soil taken from the Carson Valley were examined with special reference to water-soluble constituents, and transpiration experiments were made with wheat plants grown in water extracts of various types of the soil. The investigations on the digestibility of native grasses and forage plants were completed and have been partially reported upon.^b Investigations on poisonous plants were temporarily discontinued during the year, pending the appointment of a research chemist. The studies of parasitism of the codling moth and of the food habits of *Aphidia* and *Inocellia* were interrupted during the year by severe spring frosts, which destroyed the apple crop and so nearly exterminated the codling moth that there was little or no material for study.

In addition to the above Adams fund projects, experiments were continued with apples and ornamental trees and shrubs, including tests of varieties, methods of culture, and adaptability. A study of the flora of the State was also continued by the botanist.

In animal husbandry and agronomy, investigations and experiments were made on duty of water in the growing of wheat, oats, alfalfa, and roots; time of irrigation as related to yield and composition of grain in the case of wheat and oats, in cooperation with the chemist; breeding of drought-resistant varieties of wheat, oats, and alfalfa; the growing of grain and alfalfa without irrigation; digestion experiments with alfalfa hay and silage, in cooperation with the chemist; cost of milk and butter production and tests of the value of dairy breeding in milch cows; production of winter lambs for the San Francisco market; and production of high-class breeding stock with Percheron horses, Berkshire swine, and Shropshire, Hampshire, and Dorset Horn sheep. The irrigation experiments were carried on as in previous years in cooperation with this Office.

^a Nevada Sta. Buls. 67 and 68.

^b Nevada Sta. Bul. 64.

Cooperative experiments on the Truckee-Carson reclamation project near Fallon, in cooperation with the Bureau of Plant Industry of this Department, were closed out during the year.

The entomologist carried on tests of various oil emulsions for scale insects; observations on the spread of scale insects; and studies of the cabbage louse and butterfly, and of ant infestation of houses, as well as of methods of photographing insects.

The investigations of the station in general during the year yielded valuable information as to seed production in alfalfa; ornamental shrubs suited to the climatic conditions of Nevada; the maintenance of apple orchards without irrigation and areas specially suited to apple culture; the relative value of various native and introduced species of *Trifolium*; the possibilities of economy in the use of irrigation water in growing grain; the effect of irrigation on the growth and quality of grain; the profitable production of spring lambs; improvement of breeding stock; the nature and treatment of equine anemia; the construction of a long-period meteorograph and of a snow sampler and weigher; and the action and value of forests in conserving snow as a source of supply for irrigation water.

The station began during the year the publication of a series of circulars of information, of which the first dealt with glanders. The following bulletins of the station were received during the year: Bulletins 63, Annual report of the board of control, the director, and the members of the station staff for the fiscal year ending June 30, 1907; 64, Digestion experiments with the native hay of the Truckee meadows; 65, the European elm scale (*Gossyparia spuria*); and 67, the Mount Rose Weather Observatory, 1906-7.

The income of the station during the past fiscal year was as follows:

United States appropriation, Hatch Act.....	\$15,000.00
United States appropriation, Adams Act.....	11,000.00
Farm products	1,355.40
Miscellaneous.....	25.00
Balance from previous year, farm products.....	648.48
Total.....	28,028.88

A report of the receipts and expenditures for the United States funds has been rendered in accordance with the schedules prescribed by this Department and has been approved.

The Nevada Station made notable progress during the year in perfecting its organization, improving equipment, and developing important lines of work.

NEW HAMPSHIRE.

New Hampshire College Agricultural Experiment Station, *Durham.*

Department of New Hampshire College of Agriculture and Mechanic Arts.

W. D. GIBBS, D. Sc., *Acting Director.*

Among the changes during the year at the New Hampshire Station were the resignation of W. H. Pew, as animal husbandman, F. W. Morse, as chemist, and of several assistants. Since the close of the year E. D. Sanderson has resigned as director, taking effect January 1, 1910. In April, 1909, C. W. Stone was placed in charge of the college farm and herd previously managed by the agronomist and animal husbandman. A new insectary of original design was constructed for entomological work. This consists of a permanent wooden work room and a rearing room with cement floor and pits, screen sides, and a double canvas roof. This arrangement secures more nearly natural conditions for life history studies than in the usual glass house. The work of the station was along the same lines as indicated in the last report.

The Adams fund projects were carried forward during the year. The department of chemistry made a study of soil potash and its behavior toward growing crops, which indicated that for heavy clay loams application of potash fertilizers are unnecessary for grass culture. The composition of the crop was not affected by the potassium supplied. The same facts appeared to hold for the lighter loam soils overlying clay or hardpan. The action of soils, and particularly of clay, on lime and chemical fertilizers appeared to be a reduction of their solubilities. The action of the organic matter toward the soluble mineral salts was found to be like that of clay except in a less degree.

In the horticultural department the studies of heredity in vegetables, especially squashes and tomatoes, progressed actively in accordance with the outline. The work on the cause and means of control of fruit bud formation on the apple was carried on systematically in an orchard of $8\frac{1}{2}$ acres. So far the work has been preparatory and includes the effects of different kinds of culture and cover crops and the use of fertilizers in different combinations.

The entomologist continued his investigations upon the relation of temperature to the transformations and mortality of insects. The project on the codling moth was completed and the published report ^a gives for the first time a detailed account of the life history of the pest in New England and establishes definitely such vital points as the place of oviposition and the time of hatching eggs.

^a New Hampshire Sta. Rpts. 1907-8.

The sheep breeding project was thoroughly organized and an arrangement made for cooperation with the Carnegie Institution, Station for Experimental Evolution.

The botanist practically completed his project on the fruit spot of apples. The disease was definitely shown to be due to a fungus which was studied, and methods of control by spraying were demonstrated.

Results are also reported from the activities of the station supported by the Hatch fund. The horticultural department made considerable progress in work on varieties of lettuce, with strawberries on the correlation of leaf and stem characteristics with characteristics of the fruit, carnation breeding, and some vegetables. In a new plum orchard varieties and commercial possibilities of plum culture are being tested.

The agronomist continued work in corn breeding and tested field and ensilage corn and small grains; the fertilizer work on the grass plats was also continued. Cooperative tests of alfalfa carried on with farmers gave some indications that this crop may be successfully grown under favorable conditions. Considerable attention was given to the testing of seeds for purity. A pure-seed law was passed by the legislature and placed in charge of the state board of agriculture for execution. The tests for the board will be made by the station. Work on the renovation of worn pastures was also followed.

The dairyman collected data on farm butter making and made some tests of cows for farmers.

The botanist cooperated with this Department in spraying work on leaf spot, scab, and other diseases of fruit. Lime-sulphur and Bordeaux mixtures were compared. A study was also made of the tomato point rot which is troublesome in the greenhouse. Results thus far indicate that it is not due to the presence of a fungus or enzym. The station also cooperated with this Department in farm management studies.

The following publications were received from the station during the year: Bulletins 137, Strawberries for New Hampshire; 138, Humus in New Hampshire soils; 139, Caterpillars injuring apple foliage in late summer; and 140, Analyses of feeding stuffs and fertilizers; Circulars 1, Mixing chemical fertilizers on the farm; 2, Testing soils for fertilizer needs; 3, The apple leaf aphid; 4, The oyster-shell scale; 5, The San José scale; and 6, A circular of information concerning the New Hampshire Agricultural Experiment Station; and Scientific Contributions 1, The influence of minimum temperatures in limiting the northern distribution of insects; and 2, The fruit spot of apples.

The income of the station during the past fiscal year was as follows:

United States appropriation, Hatch Act-----	\$15,000.00
United States appropriation, Adams Act-----	11,000.00
Miscellaneous -----	4,078.44
Total -----	30,078.44

A report of the receipts and expenditures for the United States funds has been rendered in accordance with the schedules prescribed by this Department and has been approved.

Much progress was made in organizing the business and various activities of the New Hampshire Station, and at the close of the year it was regarded as in a prosperous condition and doing more effective work than at any previous period in its history. Difficulty between the director and the board, arising largely out of the disposition of members to take the direction of the station into their own hands, led to the enforced resignation of the director in the early fall. This action was taken in the face of the improved administrative conditions, the interest the station was arousing in its work in the State, and the protest of the president of the college. It was a distinct blow to station administration through the director, and the result of a wrong conception of the duties and functions of board members. So long as conditions continue in the board which make such an act possible the future of the station will remain uncertain, and it can not attain its highest efficiency.

NEW JERSEY.

New Jersey State Agricultural Experiment Station, *New Brunswick.*

At Rutgers College.

E. B. VOORHEES, D. Sc., *Director.*

New Jersey Agricultural College Experiment Station, *New Brunswick.*

Department of Rutgers College.

E. B. VOORHEES, D. Sc., *Director.*

No new experiments were planned or carried out during the year, the lines of work being practically identical with those heretofore reported. The State Station is in charge of inspection work and the analyses of fertilizers, feeding stuffs, insecticides, and similar materials. On April 1, 1909, B. H. A. Groth was appointed plant physiologist of the station and has, since the close of the fiscal year, entered upon his duties. With full facilities for work both in the field and the laboratory, he is devoting his entire time to research. In order to enlarge the facilities of the department of soil chemistry and bacteriology a new greenhouse was added to its equipment.

Much progress was made during the year in the investigations under the Adams Act which, as in previous years, are confined to plant breeding and the chemistry and bacteriology of soils. The plant-breeding work is largely being conducted with sweet corn, beans, eggplants, tomatoes, peas, peppers, and squashes. With each crop a special problem is being studied, and the underlying principles influencing the form and character of the different fruits are considered. The tendency to sterility due to inbreeding and to weakness resulting from crossing plants normally close fertilized is also studied. A large number of hybrids and crosses has been obtained and observations on their differences are made.

The department of soil chemistry and bacteriology, in charge of the other Adams project, is working on the principles affecting the production of plant food, with special attention to soil fertility in relation to the bacterial flora. Denitrification and the relative availability of different forms of nitrogenous material, as well as the soil nitrogen balance are studied. The diffusibility of nitrogen taken up by leguminous plants to nonleguminous ones growing in the immediate proximity is made the object of one experiment (Pl. VII), and the study of the pure cultures sold for inoculating leguminous crops is the object of another. Several experiments are in progress to determine the bacterial changes going on in the soil and how these, as well as the growing crop, are influenced by different methods of treatment.

The horticultural department is continuing its cooperative work with peaches at Highbridge and Vineland with excellent results, although the orchards are not in full bearing as yet. These investigations are conducted upon a commercial basis with a view to solving the most important problems of peach culture within the State, and thereby encouraging the fruit growers and placing the industry, if possible, upon a firmer footing. A bulletin was published during the year giving directions and advice with reference to setting out peach orchards and caring for them during their early growth, based upon the work in this line. At Vineland, field experiments with grapes are also carried on, conducted in cooperation with the Bureau of Plant Industry. Both lines of work at this point were inspected the past summer by members of the State Horticultural Society.

In the entomological work special attention was given to the importation of the brown-tail moth and its possible spread in the State.

The mosquito work, for which \$15,000 was allowed, and the study of Paris green and other insecticides carried on under state appropriations, have been temporarily suspended, owing to the failure of the legislature to make further provision for these investigations. The mosquito work is now pursued only locally under the advice of the station entomologist. A bulletin reporting in part the observa-



FIG. 1.—PEAS IN OUTER POTS; OATS IN INNER POTS. POROUS INNER POT ON LEFT GLAZED INNER POT ON RIGHT.



FIG. 2.—VETCH IN OUTER POTS; RYE IN INNER POTS. POROUS INNER POT ON LEFT; GLAZED INNER POT ON RIGHT.

Method devised at New Jersey Station for studying appropriation of nitrogen by cereals grown in conjunction with legumes.

tions made and the results obtained in the mosquito work was issued during the year. Studies of insects affecting sweet potatoes, strawberries, and cranberries, as well as a study of fruit maggots, cabbage maggots, flea beetles, and plant lice, are also in progress. Considerable attention was given to the study of insecticides, which is carried on in cooperation with the department of chemistry of the station. The value of miscible oils in combating insect pests was made a subject of inquiry in this connection. During the year a bulletin on the application of insecticide materials and one on the composition of Paris green and lead arsenate were published.

The work on oysters by the department of biology, which has been in progress for a series of years, is now largely confined to determining the relation between the temperature of the water and the time of setting spawn. Different methods of setting spawn are also receiving attention. This work was conducted under state aid, but provision for its continuance was not made by the legislature.

Demonstration work and cooperative experiments continued to be a prominent feature of the stations' activities. The field day for farmers at the station, established by the State Board of Agriculture, was largely attended this year and was an excellent means of acquainting farmers with the station work.

The publications received from the stations during the year were as follows: Bulletins 213, Insecticide materials and their application, with suggestions for practice; 214, Analyses of Paris green and lead arsenate; 215, Analyses and valuations of commercial fertilizers. Analyses of fertilizer supplies, home mixtures, and special compounds; 216, The house mosquito—a city, town, and village problem; 217, Analyses and valuations of commercial fertilizers and ground bone; 218, Vegetable-fruit seed distribution for 1909; and 219, The first season with the peach orchard.

The income of the station during the past fiscal year was as follows:

State Station: State appropriation (fiscal year ended	
October 31, 1909)-----	\$38, 806. 18
College Station:	
United States appropriation, Hatch Act-----	15, 000. 00
United States appropriation, Adams Act-----	11, 000. 00
Total-----	64, 806. 18

A report of the receipts and expenditures for the United States funds has been rendered in accordance with the schedules prescribed by this Department and has been approved.

The value and the appreciation of the work of the stations is manifested by the close touch of the agricultural population of the State with the institutions.

In addition to their inspection and special work, the stations are exerting a strong influence in the State, which is reflected in improved methods of farm practice and larger returns.

NEW MEXICO.

Agricultural Experiment Station of New Mexico, Agricultural College.

Department of New Mexico College of Agriculture and Mechanic Arts.

LUTHER FOSTER, M. S. A., *Director.*

Numerous changes on the staff of the agricultural experiment station occurred during the year and at its close. L. A. Pringle, assistant in chemistry, was succeeded by A. P. Bjerregaard, and E. Heringa, assistant in the soil physics department, was succeeded by W. L. Powers. J. B. Stoneking was employed as an assistant in the irrigation department. At the close of the year, P. C. Standley, assistant in botany, accepted a position with the Smithsonian Institution, and was succeeded by E. I. Werber. W. G. Hummel resigned his position as assistant in agronomy and his place was filled by the appointment of J. H. Squires. Since the close of the fiscal year, B. P. Fleming, in charge of the irrigation work, has accepted a position in the University of Iowa and has been succeeded by F. L. Bixby, of this Office.

Wilson Hall, the new agricultural building, was completed and ready for occupancy about the middle of the year. This building furnishes offices and laboratories for the departments of agronomy, animal husbandry, horticulture, and irrigation engineering, in addition to an office for the director and room for the station library. Other minor buildings were constructed in different departments for the protection of machinery and for storage purposes. The legislature gave no direct assistance to the station at its last session, and failed to make the usual appropriation for farmers' institutes.

The Adams fund projects under way were carried forward during the year and in some of them material progress was made. In the cactus studies, additional data were obtained this season from the older bearing plants in regard to the quantity of fruit which will probably be produced by these plants when they reach bearing size. The results have also pointed out the necessity of spines as a protection against rabbit depredations and the sensitiveness of the plants to change of soil and altitude and to the diminution of the water supply. Culture tests with spineless cacti are in progress and preparations for breeding work are being made. A bulletin reporting the results of experiments on the digestibility of prickly pear by cattle was issued during the year. The results thus far secured in the rubber-plant investigations with the guayule have all been negative.

Experiments in connection with the irrigation project indicate a loss of water by percolation below 6 feet when the land is irrigated to a depth of 6 inches. Four 3-inch irrigations where a soil mulch was maintained produced the largest yield. Pot experiments in this connection showed that apparently a 3-inch mulch, the cost of maintenance considered, is more economical and effective than either a 6-inch or 9-inch mulch on a sandy loam soil, under the climatic conditions of the locality.

In the improvement work on chillies, the horticulturist has under observation 15 strains of these plants secured by selection. In the crown-gall work, 100 varieties of grapes are being studied to determine their relative resistance to the disease and other points of value. A severe freeze in 1907 destroyed the apple crop and interfered with the progress of the codling-moth project. It was found impossible, however, to starve out this insect, and it was observed that the moth flies longer distances than is usually supposed.

Under the Hatch fund studies were made on the adaptability of small fruits to Mesilla Valley conditions, resistance of peach buds to cold, low pruning of peach trees to prevent sun scald, tests of varieties of grapes and apples for sandy soils, summer, fall, and spring pruning, and of sweet potatoes, celery, onions, cantaloups, and other vegetables, as well as some ornamentals. The study of range problems was continued, and a bulletin on the grasses is ready. On the station farm, variety tests of cereals, studies of cost of production, distance experiments, fertilizer trials, and rotation experiments were made. Cattle, lamb, and pig feeding experiments were conducted with success, the object being to test the value of alfalfa and various supplementary feeds.

The following publications were received from this station during the year: Bulletins 66, The range problem in New Mexico; 67, Chili culture; 68, Injurious insects; and 69, Experiments on the digestibility of prickly pear by cattle; numerous press bulletins; and the Annual Report for 1908.

The income of the station during the past fiscal year was as follows:

United States appropriation, Hatch Act-----	\$15,000.00
United States appropriation, Adams Act-----	11,000.00
Fees -----	100.15
Farm products-----	4,213.22
Miscellaneous (including cooperative receipts)-----	1,300.00
Total-----	31,613.37

A report of the receipts and expenditures for the United States funds has been rendered in accordance with the schedules prescribed by this Department and has been approved.

Good progress was made by this station in the study of problems of the greatest importance to the agriculture of the Territory, and the results are contributing in an important way to the advancement of the farming interests of the entire southern plateau region.

NEW YORK.

New York Agricultural Experiment Station, *Geneva*.

W. H. JORDAN, D. Sc., *Director*.

The principal investigations of the New York Station during the year differed very little from those outlined in the last report. The State granted an appropriation of \$10,000 for a study of grape production in Chautauqua County, including methods of culture and the ravages of insect pests and fungi. No material change was made in the equipment of the station nor in its staff of workers.

The Adams fund of the station was applied entirely to studies on the function of phytin in animal nutrition and to investigations on cheese bacteria and the changes they induce. Progress was made in both of these lines of work. In the work on phytin, an endeavor was made to determine whether the acid radical or the base end is responsible for the physiological effects observed when it is fed to animals. Calcium salt of phytin tried on a cow had no effect, and the studies were extended to other farm animals. The bacteriological changes occurring in the process of cheese curing, and the changes in the chemical composition which take place during the entire period of the ripening process, were studied a second time in the past year. The chemist, who cooperates with the bacteriologist in this project, gave special attention to casein salts.

The greater number of investigations at this station were conducted with the Hatch and state funds. The horticultural department continued its work on fruit as a main feature. Considerable attention was given to the preparation of a monographic work on plums in New York. The station maintains a collection of 15,000 varieties of fruit, which is held to be of the greatest value in making accurate descriptions of varieties in issuing these monographs. In addition to these lines of work, forcing house studies in plant nutrition, fertilizer experiments with apples, tests of tillage and sod mulch in apple orchards, observations on the growth of dwarf apple trees and of grapevines on resistant stocks, cultural and fertilizer experiments with grapes, extensive studies in plant breeding and greenhouse studies with tomatoes, lettuce, cucumbers, and muskmelons were pursued.

The chemist studied the soluble constituents of milk by filtering milk with the Briggs apparatus and determining the constituents

in the serum. A chemical study was also made of the lime-sulphur mixture used for sprays. The effect of different kinds of lime was investigated, and it was found that lime containing magnesia does not give as concentrated a solution for spraying as lime containing no magnesia.

The entomologist also worked with lime-sulphur sprays to determine whether they are as recommended, whether they can be used in gas-spraying machines, and whether arsenicals can be applied with them. The extent of dilution has received attention, and it is urged that the sprays should be standardized as they are now on the market in commercial form. Studies were further made of cabbage root maggots, maple Eriophyidæ, apple and pear leaf hoppers, clover mite, lesser tarnished plant bug, and the cherry ermine moth. The brown-tail moth, the snowy tree cricket, the leaf blister mite, and the leaf hoppers and their secondary hosts were also studied.

The bacteriological department, in addition to its Adams fund work, also studied the milking machine with reference to the germ content of the milk. It was found that cleaner milk can be obtained with the machine than by hand milking, provided care is exercised.

In agronomy some of the pot experiments with fertilizers were continued; and a variety of field experiments were carried on.

The cooperative work of the station with farmers included experiments in potato spraying and controlling currant cane blight, cabbage black rot, and the cabbage maggot. The cooperative work with this Department consisted in growing sugar beets and studying the control of the Hessian fly. The station did no extension work, but took part in farmers' institute work to some extent.

The following publications were received from this station during the year: Bulletins 299, popular edition, May weather and fruit harvests; 302, popular edition, Is it wise to dip nursery stock? 303, Inspection of feeding stuffs; 304, Report of analysis of samples of fertilizers collected by the commissioner of agriculture during 1908; 305, Troubles of alfalfa in New York (with popular edition); 306, Control of leaf blister mite in apple orchards (with popular edition); 307, Potato spraying experiments in 1907 (with popular edition); 308, Methods of paying for milk at cheese factories (with popular edition); 309, Variety test of strawberries and cultural directions (with popular edition); 310, Director's report for 1908; 311, Potato spraying experiments in 1908 (with popular edition); 312, The tussock moth in orchards (with popular edition); 313, Inoculation and lime as factors in growing alfalfa (with popular edition); 314, A comparison of tillage and sod mulch in an apple orchard (with popular edition); and 315, The grape districts of New York and table of varieties; Technical Bulletins 7, The *Sporotrichum* bud rot

of carnations and the silver top of June grass; 8, The bacterial flora of Cheddar cheese; and 9, A *Mycosphærella* wilt of melons; Circulars 8, Dodder in alfalfa seed; 9, Remedies for the San José scale and directions for their use; and 10, Lime and liming; and the Annual Report for 1907, pts. 1, 2, and 3.

The income of the station during the past fiscal year was as follows:

United States appropriation, Hatch Act-----	\$1, 500. 00
United States appropriation, Adams Act-----	1, 100. 00
State appropriation -----	122, 328. 09
Balance from previous year, state appropriation-----	7, 230. 78
Total -----	132, 158. 87

A report of the receipts and expenditures for the United States funds has been rendered in accordance with the schedules prescribed by this Department and has been approved.

The New York Experiment Station is in a very prosperous condition and enjoys the generosity of the State and the support of the state commissioner of agriculture, who works hand in hand with the institution. The members of the staff devote themselves entirely to station work and enjoy the advantage of having no college duties. The station is strongly organized and equipped in a number of departments, and is prosecuting its work in an active and efficient manner.

Cornell University Agricultural Experiment Station, Ithaca.

Department of New York State College of Agriculture at Cornell University.

H. J. WEBBER, Ph. D., *Acting Director.*

The Cornell College and Station during the year continued to advance their educational and research work in agriculture, and to increase materially the experimental equipment in several departments. The new greenhouses for the college, for which the last legislature appropriated \$30,000, were under construction during the year and when completed two of them, each 23 feet by 50 feet, will be used by the station. The plans of these greenhouses provide for a building with about 10,000 square feet of glass, in addition to laboratories and potting sheds with about 6,800 square feet of floor space. A new barn for which \$25,000 had been appropriated was under construction during the year. This barn will be for station use in so far as experiments are conducted by the dairyman. The concrete tanks for soil investigation, described in the last annual report of this Office, were completed during the year and partially brought into use.

M. V. Slingerland, for many years connected with the station as entomologist, died March 10, 1909. He had been an energetic and

efficient investigator in his field. A number of assistants were employed during the year;* otherwise no changes on the station staff occurred. At the close of the fiscal year L. H. Bailey was given leave of absence for the ensuing academic year, during which time H. J. Webber serves as acting dean and director.

The facilities as well as the personnel for Adams fund work were increased during the year. In connection with these projects a large amount of breeding work was done principally with phlox, tomato, pepper, verbena, and certain other plants, for the purpose of studying heredity and segregation of hybrids. Studies of mutations and their influence in the production of varieties included an extensive examination of chemical injections on a pure line of wild Silene. An investigation of the causes and range of variations, including studies of variation in wild and cultivated plants under varying conditions, was conducted with timothy, peas, buckwheat, wheat, oats, and other crops under different soil and fertilizer conditions. With potatoes a study was made of bud variation and of the possibility of fixing and transmitting certain types by selection.

The soil fertility project included pot culture experiments with wheat and oats, and a study of poor spots in soils to determine the reason of their existence. Bacteriological studies of the flora of these soils were also carried on. Lime and inoculation experiments with alfalfa were conducted as part of this project to determine whether the plant gives up nitrogen to the soil while it is growing. Timothy grown with alfalfa contained a higher nitrogen content than that grown alone, and the difference was greater on a soil well supplied with lime than with one deficient in that constituent.

The entomological work under the Adams Act was confined to a study of the joint-worm flies infesting grains and grasses. It was considered necessary to extend this project to include certain closely allied insects infesting various seeds. Two species of these seed-infesting chalcis flies were found to be of considerable economic importance, and the result of the study of this phase of the subject was published in bulletin form.^a

The Hatch fund work included fertilizer experiments with timothy in rotation with corn, oats and wheat, observations on the effect of weeds on corn, experiments with lime and inoculation for alfalfa, and breeding work with timothy, corn, oats, wheat, and cowpeas.

It was found that the growth of alfalfa increased the nitrifying power of the soil, and that this was more marked on a soil well supplied with lime than one deficient in the latter. Certain non-leguminous crops exhibited definite relations to the formation of nitrates in the soil, but this property differed with different crops.

^a New York Cornell Sta. Bul. 265.

The absorption of nitrate nitrogen by wheat plants grown on a rich soil was not proportional to the growth of the plants but increased with a decrease in the soil moisture content and consequently with a decrease in the crop.

The extensive studies of timothy brought out the existence of a large number of very distinct biotypes which probably originated as mutations. It was found that by self-fertilizing these types they reproduced true and that such self-fertilized plants lost but little if any in vigor as the result of self-fertilization. Observations on the correlation of characters in corn have brought out a considerable degree of correlation of characters determinable at the time of blossoming with high yield, and some of these characters are considered as possibly serviceable in selecting individuals to breed together at time of flowering. The range of variation in yield, height, time of flowering, and duration of flowering of timothy as affected by seasonal changes was also determined.

Along entomological lines it was determined that the knottiness of apples caused by the punctures of the red bug has heretofore been confused with a similar injury caused by plant lice and the plum curculio. A study of the life history showed that treatment directed against either of these insects would not control the red bug, and a promising treatment has been suggested.

A number of lines of work representing a very large portion of the experimental work of the college were inaugurated and conducted with state funds. The department of soil technology carried on its investigation on soil granulation. The department of farm practice installed an experimental drainage system on the upland fields of the university farm, and continued its work on fertilizers for mangels, the results of which were published during the year.^a The horticultural department continued its work on orchard surveys and also began a survey of the strawberry regions of the State during the year. Other work of this department included experiments with various sprays in the control of black rot of grapes, experiments in orchard management, the effects of fumes of ether and chloroform in hastening the flowering of bulbs, experiments with cucumber hybrids, the effect of cloth shade in growing vegetables, and fertilizer tests in growing tomatoes. In addition a systematic study of varieties of the peony and sweet pea was made for the purpose of securing authentic descriptions of the various forms under cultivation.

The department of plant pathology investigated grape diseases, bean diseases, pear blight, and ginseng diseases, and tested in this connection the value of commercial lime-sulphur as a fungicide.

^a New York Cornell Sta. Bul. 276.

It was clearly demonstrated that bean anthracnose can be controlled by selecting clean pods for seed. The injury from fire blight on nursery stock from large orchards was effectively controlled by the prompt removal of infected blossoms and twigs from the trees, together with disinfection of the cuts. The test of lime-sulphur as a summer spray showed clearly that this spray gave fruit entirely free from injury and at the same time as free of scab as apples sprayed with Bordeaux mixture. Arsenate of lead was used with lime-sulphur with perfect safety to fruit and foliage and was just as effective for the control of the codling moth as with Bordeaux mixture.

The individual records of the production of different cows in about 20 herds were collected, and studies made of sanitary and market milk problems, the operation of cream separators upon the completeness of skimming, the moisture content of butter, Camembert cheese making, and the leucocyte content of milk from different cows.

The poultry department worked on numerous projects with reference to breeding, feeding, incubation, and brooding. A vast difference in the hatching quality of eggs as due to the method of keeping was observed. Eggs kept at 45 or 50° gave much better results than those kept at a temperature of 70° or higher. It was also learned that eggs lose fertility in hatching power rapidly unless kept under favorable conditions after the third week.

The department of animal husbandry continued experiments on feeds for dairy cattle, and the conduct of the advanced registry for dairy cattle based on actual production of butter fat.

In connection with the extension work of the college a considerable number of cooperative experiments are being conducted with farmers throughout the State. The station cooperates with this Department in the plant-disease survey work and the breeding of cereals. No extension work is conducted by the experiment station staff other than to give occasional lectures in state fair exhibitions.

The publications received from this station during the year were as follows: Bulletins 254, Drainage in New York; 255, Bean anthracnose; 256, Street trees, their care and preservation; 257, Defects in American Cheddar cheese; 258, The molting of fowls; 259, The peony; 260, American varieties of beans; 261, Third report on the influence of manures on the yield of timothy hay; 263, Necrosis of the grapevine; 264, Experiments in the growth of clover on farms where it once grew but now fails; 265, On certain seed-infesting chalcis flies; 266, The black rot of the grape and its control. Second report; and 267, Fertilizer and seeding experiments with root crops; Circulars 1, Testing the germination of seed corn; 2, Fungicides; 3, Some essentials in cheese making; 4, Soil drainage and fertility; 5, Suggestions from a survey of the trucking region of eastern Long

Island; 6, Suggestions concerning treatment of seed corn with deterrents against crows; and 7, An apparatus for measuring acidity in cheese making and butter making; and the Annual Report for 1908.

The income of the station during the past fiscal year was as follows:

United States appropriation, Hatch Act-----	\$13, 500. 00
United States appropriation, Adams Act-----	9, 900. 00
Total -----	23, 400. 00

A report of the receipts and expenditures for the United States funds has been rendered in accordance with the schedules prescribed by this Department and has been approved.

The State appropriated \$175,000 for the maintenance of the college of agriculture, an increase over last year of \$25,000. A new law provides for the appointment by the governor of five members on the Cornell board of trustees, to include the commissioner of agriculture and the state superintendent of education. The station is doing valuable work along a variety of lines.

NORTH CAROLINA.

North Carolina Agricultural Experiment Station, West Raleigh.

Department of North Carolina College of Agriculture and Mechanic Arts.

C. B. WILLIAMS, M. S., *Director.*

The North Carolina Station followed the same lines of investigation pursued the year before, when the station was brought under the management of a distinct board of control and its connection with the state board of agriculture terminated. The different lines of work were developed during the year and the station proceeded on a more settled and efficient basis. In March, 1909, the legislature passed a bill providing for paying for the printing of the bulletins and reports of the station. A new barn, costing \$2,500, was built on the station farm to replace the one destroyed by fire.

During the year Tait Butler, veterinarian and animal husbandman, resigned to take up editorial work. J. L. Burgess, formerly of this Department, was appointed to conduct work in the study of leading southern crops, their improvement, and their adaptation to type soils. I. O. Schaub, assistant in soils at the Iowa Station, was appointed to carry on similar work at this station, but was later put in charge of extension work.

The Adams fund projects were materially strengthened during the year by extra equipment and more workers. The work on apple and lettuce diseases was actively prosecuted, and a large collection of apple-leaf spot made for preliminary study; the life history of the lettuce drop disease, and a bacterial disease of lettuce were worked

out. The studies in nitrification have shown the old solution method to be unreliable and work on devising new methods was instituted. Seventy-one per cent of the Raleigh soils failed to nitrify. Statements concerning this part of the work were recently published in *Science*.

In studying the relation of the geology and chemistry of soils to productivity and fertilizer requirements, data have been collected for 44 plats on the station farm where different fertilizers have been applied to corn and cotton. Chemical and bacteriological studies of the soils are made in this connection. The object of one phase of the work is to determine how far plants can use ammonia. Investigations on "double flower" and sterility in blackberries and dewberries were pursued. Many varieties planted at the station are observed to determine the cause of sterility and how it may be overcome.

Investigations on the toxicity of cotton-seed meal were essentially experiments with pigs first fed whole meal and afterwards various extracts carefully prepared. Superficial observations and examinations of the blood and urine as well as post-mortem examinations were made. Some of the extracts appeared more harmful than others.

Under the Hatch Act the new fig anthracnose was studied, investigation of cabbage diseases was undertaken, feeding experiments with live stock and poultry were conducted, and studies of some insects were made.

The poultryman compared meat meal, cotton-seed meal, and bone meal with corn and bran in different combinations as feed for poultry, and made breeding experiments with reference to egg production and vitality.

In feeding experiments with pigs a corn ration was compared with rations containing 7 parts of corn to 1 of cotton-seed meal, 4 of corn to 1 of cotton-seed meal, and 1 of linseed meal to 4 of corn. Feeding experiments with cotton-seed meal were also made with horses and mules. The data thus far collected in this work are regarded as preliminary. Apparently by using a large cotton-seed meal ration in feeding dairy cows more butter was produced and a saving effected of 20 cents per hundred pounds of feed, together with the production of more manure.

The entomologist made experiments in fumigation to find a substitute for carbon bisulphid in destroying the corn weevil. Studies on the verification of the life history of the plum curculio were made and the harlequin cabbage bug was also studied.

The following publications were received by the Office during the year: Bulletins 197, Some insect enemies of garden crops; 198, Handling and marketing of milk and cream; and 199, Feeding experiments with cows and calves; and the Annual Report for 1908.

The income of the station for the past fiscal year was as follows:

United States appropriation, Hatch Act.....	\$15,000.00
United States appropriation, Adams Act.....	11,000.00
Farm products.....	2,903.88
Miscellaneous.....	1,840.30
Total.....	30,744.18

A report of the receipts and expenditures for the United States funds has been rendered in accordance with the schedules prescribed by this Department and has been approved.

The affairs in general of the station appear in good condition, and the funds which are derived from federal appropriations are economically used.

Agricultural Experiment Station of the North Carolina State Department of Agriculture, Raleigh.

B. W. KILGORE, M. S., *Director.*

The principal lines of work at this station and its organization during the past year were practically the same as heretofore. The experimental work included soil investigations to determine the plant food requirements of crops grown on different soil types, the improvement of crops through breeding and selection, the introduction of new varieties of orchard fruits, trucking crop and nut culture experiments, feeding tests with beef cattle, and the study of the insect enemies of the various crops.

The field work was conducted mainly on the 4 branch substations of the department in Iredell, Buncombe, Edgecombe, and Pender counties. Considerable demonstration work is done to carry the results of these branch stations and of the laboratory direct to the farmer. In addition to this considerable farmers' institute work is performed. It is planned to have the demonstration work gradually cover the State. Bulletins and circulars are freely sent out. The range of the horticultural work in the State is unusually wide, and much interest on account of the great possibilities is exhibited along this line.

The station carried on cooperative work with the Bureau of Plant Industry of this Department in the study of the Scuppernong grape at the Pender substation. Cooperative work with tobacco was also followed.

The income of this station from the department of agriculture is about \$120,000 and about \$60,000 is devoted to experimental work in the field and laboratory and in popularizing the results.

Bulletins presenting the results of the work of the station were issued during the fiscal year ended June 30, 1909, on the following subjects: Reports on fertilizers and fertilizer inspection; commer-

cial apple culture in mountain regions; varieties of fruit for growing in North Carolina; annual report of farmers' institutes. 1908; stock feeds; report on food adulteration for 1908; variety, distance, and fertilizer tests with corn and cotton; peanut culture; the preparation of fruit and vegetables for market; and orchard spraying.

NORTH DAKOTA.

North Dakota Agricultural Experiment Station, *Agricultural College.*

Department of North Dakota Agricultural College.

J. H. WORST, LL. D., *Director.*

The North Dakota Station continued its work largely along lines previously taken up, and was favored by state aid in the development of its equipment and its experimental activities. G. L. Martin was appointed dairyman in the station, and a number of assistants were added to the staff. The erection of new buildings has allowed the agricultural department laboratory space for its soil work and for rural engineering, the botanist additional space for seed analysis, and has also improved the facilities of the veterinarian and domestic science workers. A poultry house was constructed and other minor improvements were made from general funds. An extension at the expense of \$1,500 was made to the experimental mill building. The last state legislature appropriated, among other items, \$30,000 for a veterinary building, \$3,000 for a state serum institute, \$2,500 for seed inspection, \$24,000 for the biennial period for demonstration farm work, \$10,000 for the biennial period for establishing the Hettinger substation, and \$5,000 for wheat and flour investigations.

A substation was established at Langdon on a quarter section of land donated by the citizens of Cavalier County. Work on the substation was begun during the year. A pure-seed law was enacted by the legislature under which a seed inspection laboratory will be established at the station. The chemical laboratory building was destroyed by fire December 24, 1909, at a loss on the building and equipment of \$63,000.

Work on Adams projects is mainly in the departments of chemistry, veterinary medicine, and botany. In the project on soil fertility in relation to the wheat plant, chemical examinations were made of soils from the demonstration farms and special attention given to their humus content. In following a chemical study of the nitrogen of wheat, samples of different kinds of wheat from different parts of the United States were examined. The Adams fund work of the botanist was centered mainly on rust resistance and yielding capacity of cereals as possibly connected with soil organisms. Four distinct seedling parasites of the wheat plant which persist in the soil were discovered, and it is believed that these may largely account for the

deterioration in yields. The work on swamp fever was actively prosecuted with 6 horses and an attempt was made to produce immunity by inoculation with equine blood.

Under the Hatch Act, the chemist gave considerable attention to the storing and milling of wheat, the sweating of grains in bins and stacks, the study of yeasts, and an investigation of paints, oils, and varnishes. The work on paints was supported by a fund of \$4,000, contributed by parties interested in the manufacture of paints. The inspection service of this department is quite extensive, including foods, drugs, and waters. A new law provides for sanitary examination of the buildings used for slaughterhouses, food factories, bakeries, fruit stands, hotels, and other business establishments.

Hog-cholera studies were taken up owing to an outbreak of the disease at the station, and the preparation and distribution of hog-cholera serum was followed actively. The poultry work included especially the keeping of records of egg production and the breeding up of grade fowls. Breeding experiments with reference to local conditions were also made, and efforts put forth to devise a poultry house suited to the local climatic and farm conditions. The breeding and feeding experiments were continued along the lines reported heretofore, and experiments upon exercise versus confinement were instituted.

The agricultural department made a study of barley and corn for pig feeding in continuation of the work already under way. Work on the cost of production with dairy cows was carried on and field crop breeding trials with wheat, oats, barley, corn, flax, alfalfa, and clover at the station and the 4 substations were continued with a view to improving the crops for the different districts of the State. Cultural methods also constituted a feature of the work. Much attention has recently been given to demonstration farms and substations. Nine additional demonstration farms were opened this year with funds received from the State, and field work was instituted at the substation of Langdon and the substation for the Hettinger district was located and a farm selected. The substations at Dickinson and Edgeley are well equipped and did useful work. The soil work of this department includes determinations of nitrogen and moisture for the farms at Fargo and elsewhere in the State, with special reference to the effects of rotation. Continuous grain cropping about Fargo is being given up, and the effects of corn and legumes were studied more fully during the past year. Special attention is also given to corn breeding, the introduction of corn culture, clover growing, and to winter wheat.

In animal husbandry, experiments with pigs have special reference to the economy of grain feeding, the utilization of waste products of

the farm, and to the use of pasture. The bacon type of pigs seems especially well adapted to the region. A study was also made of the cost of milk production in North Dakota and feeding experiments were conducted with sheep and steers.

The botanist continued the investigations on smuts and certain other plant diseases and tested wheat, oats, potatoes, and flax for disease resistance. The effect of hybridization of cereals upon disease resistance was investigated and the effect of the disease-resistant qualities upon the yields of standard strains was given attention. Spraying experiments for the extermination of weeds were continued.

The horticulturist planted about 8,000 forest trees, largely conifers, to determine their value for posts, fuel, and timber. The cost of production of strawberries as well as variety trials with apples, plums, and strawberries received his attention.

Cooperative grain breeding trials carried on with several hundred farmers have shown the value of particular strains and varieties of flax, oats, corn, barley, wheat, and potatoes. The station cooperates with this Department in alfalfa breeding trials, farm management studies, the study of wheats and their milling products, the study of bread and baking trials, the planting of forest plats, breeding of Holstein dairy cattle, and in making a plant disease survey. The veterinary department of the station cooperates with the Live Stock Sanitary Board of the State, and the animal husbandry department was charged with the execution of a stallion law passed by the last legislature.

The station staff did some farmers' institute work and acted in an advisory capacity in this connection. The station sent out properly labeled collections of weed seeds and of plant-disease specimens to the schools of the State. An extension department was organized in the college.

The following publications have been received from this station during the year: Bulletins 81, Practical paint tests in 1907; 82, Milling and baking test. Tests of flour sold in North Dakota; and 83, Pork production under North Dakota conditions; Special Bulletins 7, Labels and rulings; 8, Labels and rulings; 9, Chemically treated flours; and 10, Model food law bill; the Annual Report for 1907, pts. 1 and 2; and the Annual Report for 1908, pt. 1.

The income of the station during the past fiscal year was as follows:

United States appropriation, Hatch Act.....	\$15,000.00
United States appropriation, Adams Act.....	11,000.00
State appropriation	12,386.25
Balance from previous year, state appropriation.....	5,564.14
Miscellaneous	5,254.43
Total.....	49,204.82

A report of the receipts and expenditures for the United States funds has been rendered in accordance with the schedules prescribed by this Department and has been approved.

The North Dakota Station continues to be administered efficiently, and to be a highly important factor in the development of the agriculture of the State. It enjoys the confidence and support of the farmers, and the improved facilities and the greater state aid it has received have enabled a steady extension and broadening of its influence and usefulness.

OHIO.

Ohio Agricultural Experiment Station, Wooster.

C. E. THORNE, M. S. A., *Director*.

A steady and logical development of the work of this station was made during the year. No changes took place in heads of departments, and such changes as occurred in organization were mainly the addition of assistants to the staff.

The state appropriations available for the year amounted to \$118,990 as against \$84,000 the previous year. In addition the State furnished the paper required for the station's printing and correspondence, amounting in value to several thousand dollars annually. The state appropriations provided for the purchase of the Strongsville experimental farm of 125 acres. Some minor additions to equipment were made during the year, including a piggery, with yards, and improvements in the water system.

Steps were taken to develop the work in animal husbandry and milling and baking tests of cereals. An expert miller was employed to aid in the latter work. Special attention was also given to the development of cooperative and extension work. Several demonstration farms were established during the year.

A large amount of work centered around the three Adams fund projects of the station, viz, the increase and fixation of desirable properties in plants, the rôles of phosphorus and other mineral elements in animal nutrition, and the rôles of lime and phosphorus in the maintenance of soil fertility. The present outcome of these investigations is that the hope is being realized that the long-continued experiments of this station will throw light upon the relation of soil fertilization to plant composition and upon animal nutrition.

In addition to the Adams fund projects the following subjects received attention during the year: Methods of culture, comparison of varieties, and production of new varieties of the cereal crops, clovers, and other forage plants; the feeding of horses, cattle, sheep, and swine for the production of work, meat, and wool; the examination of seeds for purity and germination; the identification of weeds

and weed seeds; the control of weeds by spraying; the study of the diseases of farm crops; analytical work required in the various lines of work elsewhere enumerated, and the pursuit of special studies on the composition of soils and the effect of variations in such composition upon that of the produce of the soil; special studies on the catalpa midge, the raspberry *Byturus*, and the codling worm, together with general studies on numerous other insect pests; propagation of forest trees and the continuance of a forest survey of the State; further comparisons between the mulch and clover crop systems of orchard culture; demonstration work in orchard management, conducted in various sections of the State, and the beginning of an orchard survey of the State; and the continuance of the station's work on the maintenance of soil fertility.

The above work is supplemented by a department of cooperative experiments, which conducted dairy, variety, and cultural tests covering fourteen lines of work, in cooperation with more than 2,000 persons, located in 59 of the 88 counties of the State. The State is now divided into four districts, with a field assistant in each district, who visits as many of these cooperators as possible each year. This department is also conducting investigations in farm management, in cooperation with the Bureau of Plant Industry of this Department, and the station department of agronomy is cooperating with the same bureau in the study of varieties of barley, oats, timothy, and soy beans. The department of forestry is conducting work in forest tree planting in cooperation with several hundred farmers, and also with several public institutions. The departments of horticulture, entomology, and botany are united in a series of tests, conducted in cooperation with the owners of orchards in different sections of the State, the object of which is to demonstrate the possibility of profitable apple culture in the State. The department of entomology has investigated the apple-root louse in cooperation with the division of orchard and nursery inspection of the state department of agriculture.

The following publications of the station were received during the past year: Bulletins 184, The maintenance of fertility—statistics of production in field experiments with fertilizers and manures from 1894 to 1906, inclusive; 185, Meteorological summary—Press bulletins—Index; 193, Silage for fattening cattle; 194, The more important insects affecting Ohio shade trees; 195, Feeding work horses; 196, Meteorological summary—Press bulletins—Index; 197, The catalpa midge (*Cecidomyia catalpæ*); 198, Spring practice in economic zoology; 199, Calendar for the treatment of plant diseases and insect pests; 200, Second annual report on forest conditions in Ohio; 201, The mineral elements in animal nutrition; and 202, The raspberry *Byturus* (*Byturus unicolor*); Circulars 77, Cooperative

potato experiments for 1908; 81, Millet; 82, Cooperative forestry work; 83, Plans and summary tables of the experiments at the central farm, Wooster, on the maintenance of soil fertility, arranged for reference in the field; 84, Cooperative wheat variety work; 85, A visitor's guide to the more important features of the station's work; 86, Score cards for dent corn; 87, Papers read at the summer meeting of the Ohio State Horticultural Society held at Gypsum, Ohio, August 12, 1908, in the orchards of Mr. William Miller; 88, Recent experiments with oats; 89, Meetings of the Ohio State Horticultural Society; 90, Seasonal report of potatoes, 1908; 91, Alfalfa culture; 92, Plans and summary tables of the experiments at the central farm, Wooster, on the maintenance of soil fertility, arranged for reference in the field; 93, Carriers of phosphorus in fertilizers; and 95, Apple spraying in 1908; Reprints of Circulars 1-50; and the Annual Reports for 1907 and 1908.

The income of the station during the past fiscal year was as follows:

United States appropriation, Hatch Act.....	\$15,000.00
United States appropriation, Adams Act.....	11,000.00
State appropriation.....	118,990.00
Balance from previous year, state appropriation.....	61,628.28
Farm products.....	12,047.04
Miscellaneous	8,414.81
Total	227,080.13

A report of the receipts and expenditures for the United States funds has been rendered in accordance with the schedules prescribed by this Department and has been approved.

This station is using the liberal funds with which it is provided in the systematic and logical scientific development of its well established lines of work, and in disseminating the practical results of this work throughout the State.

OKLAHOMA.

Oklahoma Agricultural Experiment Station, *Stillwater*.

Department of Oklahoma Agricultural and Mechanical College.

J. A. CRAIG, B. S. A., *Director*.

The Oklahoma Station concentrated its efforts in 1909 on the lines of work followed during the previous year. Changes on the staff were made by the appointment of C. E. Sanborn as entomologist in place of J. F. Nicholson, who entered commercial work, of A. L. Lovett as assistant in entomology, of G. M. Lambert as assistant dairyman, and by the resignation of C. Beatty as station chemist. A new hog barn was built during the year at a cost of about \$1,200 (Pl. VI, fig. 2). A sheep barn is under way and also a large farm

barn, which will be used partly for station purposes. The State now appropriates \$2,500 annually for investigations in the use of vaccine for blackleg and serum for hog cholera.

Seven Adams fund projects are being studied, but so far no reports on the work have been published. A new project recently begun consists of breeding studies for the purpose of establishing a breed of sheep combining mutton, wool, and early breeding qualities. Another project just begun includes a study of bud development of peach and apple trees as affected by soil fertility and moisture content and of the influence of the starch stored in twigs on cold resistance during winter and early spring. Promising headway was made by the veterinary department in its work on artificial impregnation and the effect of cotton seed when fed to breeding stock. The results of some of this work are ready for the press.

Progress was also made in the study of soil moisture, air and soil temperatures, humidity, receptivity of pistils, viability of pollen, and other factors in their relation to the setting of fruit on the tomato, and definite results will be arrived at in the near future. The breeding of drought-resistant corn and sorghums was continued, together with the study of the morphological characters of the plants to determine their influence on drought resistance. The crosses and selections made in connection with this work were tested under conditions of low rainfall.

The investigations carried on under the Hatch Act were quite numerous. The veterinarian experimented with serum to prevent hog cholera, and this work has been of genuine service to the hog raisers of the State. The prevention of blackleg by means of blackleg vaccine was also given attention. Since July 1, 1908, 46 blackleg vaccinating outfits have been sent to stockmen, and the department has distributed up to the present time 768,370 doses of vaccine. Bulletins on the bacterial content of butter and the bacterial analysis of water are in preparation.

The horticultural department was engaged in weed studies, planting and testing forest and orchard trees, comparing methods of orchard cultivation and cover crops, and experimenting with garden crops.

The department of agronomy continued its work in establishing Bermuda-grass pastures, grass roots having been sent to 62 farmers of the State in the spring, and in distributing improved seed, of which samples were sent for trial to 80 farmers since March, 1908. In continuous grain culture tests the plat growing wheat continuously without manure has yielded a 6-year average of 14 bushels, while the adjoining plat treated with barnyard manure for a similar period has yielded an average of 25 bushels per acre. Plant breeding and culture tests were conducted with different field crops, spe-

cial attention being given to corn and alfalfa, which are preeminently adapted to the bottom lands of the State.

The dairy department continued experiments relating to the cost of a pound of butter and to the influence bearing on the incorporation of moisture in this product.

The animal husbandry department devoted its attention largely to feeding experiments with hogs and sheep, and worked in cooperation with the veterinary department and the department of chemistry in determining the influence of feeding cotton-seed meal to hogs. The station recognizes that stock farming must necessarily keep a leading position in the agriculture of Oklahoma, and for that reason the foundation for some work in feeding and breeding is being prepared on an extensive scale.

The department of entomology is in charge of the nursery inspection of the State, having inspected 97 nurseries since July, 1908, and is studying the hibernation of the chinch bug and methods of spraying for the destruction of orchard insects. The nursery inspection has brought this department into close touch with the nurserymen throughout the State.

Since July, 1908, the chemical department has made 314 analyses of feeds, dairy products, and miscellaneous materials. The work for the feed-inspection service was also done in this laboratory.

The following publications were received from this station during the year: Bulletins 81, Texas fever; 82, Alfalfa in Oklahoma; and 83, Alfalfa seed in Oklahoma; Circulars 11, The cattle tick; and 12, Summary of experiment station work; a press bulletin; and the Annual Report for 1908.

The income of the station during the past fiscal year was as follows:

United States appropriation, Hatch Act.....	\$15,000.00
United States appropriation, Adams Act.....	11,000.00
State appropriation	2,500.00
Miscellaneous (including receipts from dairy).....	33,402.07
Balance from previous year, miscellaneous.....	58.37
Total.....	<u>61,960.44</u>

A report of the receipts and expenditures for the United States funds has been rendered in accordance with the schedules prescribed by this Department and has been approved.

The affairs at the Oklahoma Station are apparently tending toward a better and more permanent organization, and the work of the institution is undoubtedly far-reaching in its effect upon the farming industry of the State.

OREGON.

Oregon Experiment Station, *Corvallis*.

Department of Oregon State Agricultural College.

JAMES WITHYCOMBE, M. Agr., *Director*.

Practically no change was made in the organization and policy of this station during the year. Previously well-established lines of work were developed and a number of changes and new appointments of assistants were made. H. S. Jackson succeeded C. C. Cate as assistant plant pathologist, and H. V. Tartar, B. Pilkington, and Lyman Bundy were appointed assistant chemists, the first giving his whole time to a chemical study of the lime-sulphur spray. E. J. Kraus was made assistant horticulturist vice R. W. Allen, who was appointed superintendent of the Umatilla substation. A. G. Lunn was added to the staff as assistant poultryman, and James Koeber and W. L. Powers as assistant agronomists. P. H. Spillman succeeded C. C. Clark as horticulturist at the Eastern Oregon substation, and Robert Withycombe was made superintendent of this station.

A dry farm of 220 acres, under station direction, was established at Moro, Sherman County, during the year, with a state appropriation of \$5,000 for the biennium, supplemented by an equal amount from the Bureau of Plant Industry of this Department in cooperation. Horticultural work was also begun on the Umatilla project experimental farm at Hermiston with a state appropriation of \$6,000 for the biennium, supplemented with an equal amount by the Bureau of Plant Industry. The construction of the main section of the large agricultural building was begun. This building completed, with greenhouse, is to cost \$60,000.

Eight Adams fund projects received more or less attention during the year. Investigations on pollination and irrigation of the apple, apple anthracnose, gummosis of the cherry, lime-sulphur sprays, and incubation of hens' eggs were actively prosecuted. Preliminary reports on the latter and on pollination of apples have been published.^a Studies on active principles of hops were temporarily suspended during the year. The soil leaching studies were continued.

In addition to these Adams fund projects, the following subjects received attention during the year: Long and short rotation systems for increasing soil fertility; alfalfa for hay and pasture; kale as a winter dairy feed and soiling crop; varieties of vetches adapted to the climatic and soil conditions of the Willamette Valley; breeding vetches for higher protein content; breeding kale to increase its yield and quality; cultivation versus no cultivation without weeds (in cooperation with the Bureau of Plant Industry of this Depart-

^a Oregon Sta. Buls. 100, 103, 104.

ment); irrigation on the station farm for vetches, clover, and alfalfa (in cooperation with this Office); smudging and frost protection of orchards; fertilization and culture of the loganberry; varieties of raspberries, blackberries, gooseberries, currants, grapes, and filberts; varieties, breeding, irrigation, and cultivation of strawberries; varieties, culture, and pruning of peaches; standard and dwarf varieties of pears; varieties and pruning of apples; cover crops versus culture for orchards; grafting walnuts; peach spot and celery leaf blight; spraying potatoes; chemical composition of types of Oregon soils; composition of the ground waters of the Klamath Basin and of Willamette and Columbia River waters throughout the year; composition of insecticides; mortality of incubator chicks; bacterial content of machine and hand-drawn milk; cheese curing in sausage casings; production of potato tubers by inoculation; methods of brooding chicks; tests of milking machines; variation in the fat content of hand separator cream; intensive dairying with the station herd; solids-not-fat in milk; manufacture of soft cheeses; methods of operation of cream separators; feeding skim milk to dairy calves; and feeding experiments with swine.

The college and station sent out two large demonstration trains during the year which were well received. One traversed the Willamette Valley and the other was operated in southern Oregon.

A seed-testing laboratory was established at the college in cooperation with the Bureau of Plant Industry of this Department.

The publications of the station received during the year were as follows: Bulletins 97, Comments upon the state fertilizer law; 98, Preserving wild mushrooms; 99, Orchard survey of Wasco County; 100, Incubation experiments; 101, Orchard survey of Jackson County; and 102, Digestibility of kale, vetch hay, steamed and unsteamed silage; and Circulars 2, Hints for eastern Oregon farmers; 3, Notes on nut culture; and 4, A colony house; A trapnest.

The income of the station during the past fiscal year was as follows:

United States appropriation, Hatch Act.....	\$15,000.00
United States appropriation, Adams Act.....	11,000.00
State appropriation.....	1,566.84
Miscellaneous	3,041.44
Total	30,608.28

A report of the receipts and expenditures for the United States funds has been rendered in accordance with the schedules prescribed by this Department and has been approved.

The Oregon Station continues to do much work of great value, and to improve the means of making the results available for the practical use of the farmer of the State.

PENNSYLVANIA.

The Pennsylvania State College Agricultural Experiment Station, *State College.*

T. F. HUNT, D. Agr., D. Sc., *Director.*

The principal changes on the staff of the Pennsylvania Experiment Station resulted from the resignation of J. W. Gilmore, agronomist, and the appointment of F. D. Gardner to the same position; several changes were made in the force of assistants during the year. Since the close of the fiscal year, C. L. Penny has resigned to return to the Delaware Station. The state appropriations for the current biennium for the college and station aggregate \$525,999.76. Among the items of expenditure authorized are \$176,086 for the school of agriculture and the station, \$169,050 for the school of engineering, \$9,368 for the maintenance of the department of home economics, and \$4,000 for the institute of animal nutrition.

Under the Adams Act, work on the three projects previously laid down was systematically pursued. The horticulturist continued his investigations on the causes affecting the yield and quantity of apples. In this connection a new orchard was planted on the farm recently acquired, and experiments were also in progress on private farms in about 10 different localities in the State. Some results of this study were recently published in a bulletin.^a

In the agronomy investigations, samples of the soils of the rotation plats were taken weekly for making culture experiments, and complete analyses of the soils were also made and distillates from the various soils were collected and used for watering culture pots. The distillate from soil on which a heavy crop of wheat had been grown did not have as high an effect as one from a plat producing a low yield of wheat. The degree of evenness in fertility of the experimental area was determined, and results indicated that phosphoric acid is apparently correlated with the yields.

The other line of work under this fund is conducted by the Institute of Animal Nutrition, described on page 175. Under the Hatch Act, field experiments were conducted on liming old land on which corn, oats, wheat, and a mixture of timothy and clover are grown in rotation. Tests were also made of liming soil preparatory to seeding alfalfa, and the effects of different amounts of lime were studied. The results of rotation experiments in progress for 28 years were studied and soil temperatures taken on many of the plats. The lower extremes of temperature were met with on the plats giving good yields. Cultural experiments with alfalfa mainly to determine the method of getting a stand and maintaining it were also conducted.

^a Pennsylvania Sta. Bul. 91.

Tobacco experiments were carried on as previously, supported by a state appropriation of \$5,000. A large number of cooperative experiments throughout the State to test the fertilizer needs of the soil for tobacco were in progress.

The botanist worked on clover diseases, especially an anthracnose caused by *Glæosporium*. In studies of apple canker, it was found that the disease follows insect puncture, and work on the organism and time of infection was instituted.

The dairyman conducted feeding experiments with cows and steers for the purpose of determining the effect of rations of different bulk, but all containing the same amount of digestible nutrients. With cows the results for 2 years have shown no differences. The milking machine was tested but no bacteriological work was done in this connection.

The horticulturist worked especially on tomatoes, cabbage, and asparagus. Great differences were found in the same variety of cabbage grown from seed furnished by different seedsmen. This irregularity is a serious matter to commercial growers, and the seedsmen recognizing this have taken much interest in the trials. Similar work was done with tomatoes, and tests of varieties were made including some of Halsted's originations at the New Jersey Stations. With asparagus the work was especially on the effect of subsoiling and applying fertilizers at the time of setting. Variety and fertilizer experiments were also conducted with asparagus, and variety, distance, and culture tests with other vegetables. (Pl. VIII.)

The forestry work of the station was mostly connected with the growing of seedlings and creosoting of posts.

Members of the station staff gave lectures in connection with a farm special train sent out by two railroads of the State. Later agents from 12 stations on one of the prominent railroads were sent to the experiment station to inspect the work and to have the significance of it explained to them, in order that they might be influential in bringing farmers in touch with the station work.

The following publications have been received from the station during the year: Bulletins 87, Some poultry experiments; 88, Steer feeding experiments; 89, Shelter tent experiment with Sumatra-type tobacco; 90, Soil fertility; and 91, Orchard fertilization; and the Annual Reports for 1907 and 1908.

The income of the station during the past fiscal year was as follows:

United States appropriation, Hatch Act.....	\$14, 999. 74
Balance from previous year, Hatch Act.....	. 26
United States appropriation, Adams Act.....	11, 000. 00
Balance from previous year, state appropriation.....	2, 828. 00
Fees, including balance from previous year.....	20, 336. 03
Farm products.....	10, 681. 85
Miscellaneous	1, 622. 03
Total	61, 467. 91



FIG. 1.—TRUCK GARDEN—INTERCROPPING EXPERIMENT, PENNSYLVANIA STATION.
Cauliflower, early cabbages, radishes, and onions.



FIG. 2.—GRASS GARDEN AT PENNSYLVANIA STATION.

A report of the receipts and expenditures for the United States funds has been rendered in accordance with the schedules prescribed by this Department and has been approved.

The Pennsylvania Station is broadening its work and facilities and strengthening its organization. This has been made possible by the increased appropriations from the State for the college of agriculture which the station has shared. The present organization of the teaching, investigation, and institute work allows freedom for the station investigations and experiments in a number of departments and affords opportunity for effectively placing the results before the public.

The Pennsylvania State College Institute of Animal Nutrition, State College.

H. P. ARMSBY, Ph. D., LL. D., *Director.*

As in previous years, the Institute of Animal Nutrition was conducted in cooperation with the Bureau of Animal Industry of this Department, a portion of the Adams fund of the station entering into the cooperation.

The principal part of the year's work was a continuation of the experiments on the utilization of food by growing and fattening steers, which was begun in cooperation with the Missouri Experiment Station during the preceding year. Calorimeter experiments were made with a steer representing a certain group, to make determinations of availability of energy and to compare the results obtained at the Missouri Station from analyses of the carcasses of the steers. In addition three respiration calorimeter experiments upon another steer were made to determine the energy value of corn stover.

The institute has nearly ready for publication the results of an investigation extending over three years upon the influence of age and type on the utilization of energy by cattle. Experiments were made on two animals, one a full-bred Aberdeen Angus, and the other a scrub. These animals were purchased as yearlings and were under nearly continuous observation for two and one-half years. The experiments failed to show any material influence of the type of animal or its age upon the actual physiological process of nutrition. The principal difference between the two animals lay in their maintenance requirements. For the pure-bred animal this averaged 5.1 therms of available energy per 500 kilograms live weight, which is the smallest amount thus far reported in any of the experiments. The maintenance requirement of the scrub in proportion to the surface of the animal was 7 therms, a figure approaching the maximum thus far observed.

A study of the feeding records of the animals in the periods intervening between the respiration calorimeter experiments, including

four digestion and metabolism periods, seems to show quite clearly that the amount of potential energy stored up in a pound of gain of live weight was materially greater in the case of the pure-bred animal. It is concluded that a pound of increase in the pure-bred animal, therefore, had a higher value as human food than an equal increase in the scrub.

The institute is conducting investigations on the frontier of animal nutrition. It is equipped as no other station in this country is for this special study; and its work while very technical has already proved highly practical. It is fortunate for our knowledge of the underlying principles of animal nutrition that the State and the General Government have united in promoting advanced investigation in this field.

PORTO RICO.

Porto Rico Agricultural Experiment Station, Mayaguez.

Under the supervision of A. C. True, Director, Office of Experiment Stations,
United States Department of Agriculture.

D. W. MAY, M. Agr., *Special Agent in Charge.*

The office and laboratory building provided for by the insular government has been completed, and the station for the first time is now adequately housed. Some changes were made during the fiscal year in the personnel of the station. M. J. Iorns, horticulturist of the station for three years, died May 17, and was succeeded by C. F. Kinman, formerly assistant horticulturist at the Cuban Experiment Station, with T. B. McClelland as assistant. G. L. Fawcett, formerly connected with the subtropical laboratory of the Bureau of Plant Industry of this Department, was transferred to the Porto Rico Station as plant pathologist, and William Hess, of the same laboratory, was transferred as expert gardener. Dr. William C. Taylor, of Harvard University, was appointed assistant chemist, and Dr. Oscar Loew returned to the station for a few months to carry on some investigations relating to soil problems.

The chemical work of the station has been largely a study of soils, tropical soils presenting problems totally distinct from those in the temperate regions. The investigations now in progress principally relate to nitrogen, the activity of enzymes, and drainage waters. The practical side of these investigations looks toward the renovation of those soils that are worn out from continuous cropping.

The work of the horticultural department is largely devoted to plant breeding and acclimatization, and besides the very extensive work at the station cooperative experiments are in progress with representative planters in different sections of the island.

The work of the division of plant physiology and pathology has largely been confined to diseases of citrus fruits and pineapples, and,

as time permitted, studies were made of the diseases of other fruits, sugar cane, and coffee. These investigations were carried on with the idea of determining the cause of the disease and methods of control.

In entomology special studies are being conducted on the insects injurious to citrus fruits, and the efficiency of sprays is being tested for their control. It has been found necessary to make certain modifications in the formulas recommended for insecticides and the methods of their application. An effort is being made to interest the people of Porto Rico in apiculture, and a number of hives have been sold to planters in different sections of the island. It is believed that this industry will be of considerable importance, as it will not only directly yield an added income, but will assist materially in the pollination of coffee during its short blooming periods.

The coffee work of the station has been continued at the substation at Carmelita, and arrangements have been made for experiments on a considerable scale in the renovation of an old coffee plantation. In addition to the experiments on the cost of renovating an old plantation and of establishing a new plantation, considerable work is being carried on in the introduction of coffees from different parts of the world, and during the past year a number of the highly prized Java and Mocha coffees fruited in considerable abundance. Practically all the seed of these varieties has been saved for planting, and the trees will be distributed from the nursery as rapidly as they can be grown. Tests of the new coffees have shown that they retain their characteristic flavors when grown under Porto Rican conditions.

The live-stock equipment of the station has been increased by the purchase of a number of cattle, some African woolless sheep, fowls, and other animals. The demand for these animals and their products is far beyond the station's ability to supply.

A silo was constructed at the station for the purpose of testing the advisability of storing certain crops, such as Para grass and cane tops, which are abundant at certain seasons. It was found that these make good silage for use when the supply of forage is low.

The publications of the station for 1909 consisted of the Annual Report; Bulletin 8, Pineapple growing in Porto Rico; and Circulars 8, Picking and packing citrus fruits; 9, The catalase of soils; and 10, Some principles in manuring with lime and magnesia.

The income of the station during the past fiscal year was as follows:

United States appropriation-----	\$26,000.00
Farm products -----	4,608.37
Insular appropriation for office and laboratory building	20,000.00
Total -----	50,608.37

The work of the Porto Rico Station is being well received by the people, as is shown by the appropriation for the new building mentioned above. While not overlooking the scientific aspect of the different problems, particular attempts are being made to bring out the economic possibility of the results obtained.

RHODE ISLAND.

Rhode Island Agricultural Experiment Station, *Kingston.*

Department of Rhode Island College of Agricultural and Mechanic Arts.

H. J. WHEELER, Ph. D., *Director.*

Very little change was made in the affairs of the Rhode Island Station during the year. Several changes in the corps of station assistants took place but otherwise the personnel remained the same as the year before. The State made no appropriation for buildings or for general maintenance.

The work on practically all Adams fund projects progressed satisfactorily. In the potash versus soda investigations, carried on with beets, onions, and potatoes, it was found that with potatoes the yield was smaller where soda had been applied, but that the tubers were richer in nitrogen, containing up to 2 per cent or more in the dry matter. Using like weights of tubers grown with soda and with potash fertilizers, about double the yield of potatoes was secured from the soda-grown seed. A study was made of the nitrogen content of the seed on the influence of the yield, but the results so far do not seem to indicate that the application of nitrogen to the soil counterbalances the extra amount of nitrogen in the tubers.

The work on the residual effects of the different crops is bringing to light some interesting results. Where mangels and beets had been grown onions were injuriously affected. Pot-culture tests indicated that phosphoric acid was lacking where beets and mangels had been grown and where onions were poor. Striking results were also arrived at in the investigations on turnips as an indicator of the fertilizer needs of the soil, and a large amount of data was secured in this connection. The project on the influence of physical soil factors and the various chemicals upon the growth of vegetables and flowering plants under glass was continued with roses and carnations.

The studies on the blackhead disease of turkeys and its communicability to other fowls and birds were essentially studies of the biology and life history of the coccidium, which was found very resistant to heat, cold, and various chemicals. The organism seemed most susceptible to potassium permanganate. In connection with the project on the loss of incubator chicks, coccidia were also studied, as well as

the bacterial flora and molds to determine the cause. The study of the laws governing the breeding of pigeons was actively prosecuted. A cross of the ring-necked pheasant on the bantam hen has given an interesting progeny.

The Hatch fund work of the station was conducted along the lines previously laid down. The field experiments, as heretofore, included fertilizer tests, rotation experiments, work with lime in connection with nitrate of soda and sulphate of ammonia, growing corn with crimson clover sown in the last cultivation, studies of different lawn-grass mixtures, tests with basic, neutral, and acetic fertilizers, as to their influence on weeds and permanency, comparisons of market garden rotations, and tests of fruits originated by the station.

Different forms of limestone were tested, including magnesian limestone, pure limestone, and slaked lime. The residual effects of different phosphates on potatoes were observed.

The plat work at the station is extensive and of high quality. It is supplemented to some extent in the greenhouse. The latter relates mainly to tests of different nitrogenous materials in pots, cyanamid among others, the nitrogen gathering power of crimson clover, soy beans and adzuki beans, and the residual effect of these legumes on the subsequent growth and nitrogen assimilation of vetch. In water solutions an attempt was made to grow barley to maturity and to determine the amounts of potash given back to the solution after the plants ripened. Experiments were also made to determine the stage at which cereal crops need phosphoric acid.

More than 100 cooperative experiments well distributed in every township of the State were in progress. This work had reference largely to testing alfalfa, using phosphoric acid and potash, the utilization of sandy soils, and top dressing grass lands. The station is cooperating with the Sheffield Scientific School, of Yale University, in studying the laws of inheritance as applied to pigeons, and with this Department in experiments with different varieties of Indian corn. The station is not engaged in extension work.

The following publications were received from the station during the year: Bulletins 126, Feeding experiments with chickens, cockerels, and turkeys; 127, Some recent feeding experiments; 128, A further study of soil treatment in greenhouse culture; 129, Experiments with feldspathic rock as a source of potassium; 130, Analyses of commercial fertilizers; 131, Further soil tests in paraffined wire baskets; and 132, Analyses of commercial fertilizers; and the Annual Report for 1908.

The income of the station during the past fiscal year was as follows:

United States appropriation, Hatch Act-----	\$15,000. 00
United States appropriation, Adams Act-----	11,000. 00
Individuals -----	3. 50
Balance from previous year, miscellaneous-----	5,016. 02
Miscellaneous-----	1,430. 21
Total -----	32,449. 73

A report of the receipts and expenditures for the United States funds has been rendered in accordance with the schedules prescribed by this Department and has been approved.

This station lacks state funds, which are much needed for the development of its work. It is doing thorough and high-grade work in a number of lines, and is in close touch with the problems of agricultural practice. Its extensive cooperative trials with farmers serve to extend the experiments made at the station to various localities and conditions throughout the State, and call wider attention to the results.

SOUTH CAROLINA.

South Carolina Agricultural Experiment Station, *Clemson College.*

Department of Clemson Agricultural College.

J. N. HARPER, B. S., M. Agr., *Director.*

The definite separation of the station from the agricultural department of the college, which was put into effect at the beginning of the fiscal year, involved the equipment of some new laboratories and the laying out of new horticultural and agricultural grounds. The time required for this work interfered in a measure with experimental work during the season, but the new arrangement gave good promise of working out satisfactorily, and it is the intention to make it permanent. The new fields for the agricultural and horticultural departments are for the exclusive use of the station, and 30 acres of the area have been terraced and prepared for permanent plat work. A house for the horticulturist and a field laboratory building for the different departments have been erected on the new horticultural grounds.

The farm of the substation at Jadburg was drained according to plans made by this Office. The clearing of the land and other general preparations to get the station in readiness for work were continued. Experimental work has been planned and will be taken up as soon as conditions permit. The annual income of the substation is \$10,000, which is derived from the fertilizer tax and covers buildings, equipment, and general maintenance.

Progress was made in all Adams fund projects. The study of the effect of pollen from barren corn plants was continued, and a large

number of crosses and selections obtained in this work were tested under field conditions.

In pursuing the work on the relation of soil to length and quality of staple in cotton, samples of several varieties of seed were sent out and grown in different sections of the State where pronounced soil types were represented. Samples of the cotton produced were graded and judged at the station, and samples of the different soils on which the cotton was grown were sent in for examination. The project with reference to anthracnose in cotton was carried forward. It was determined that this fungus lives during the winter in a conidial stage, being found alive in that form as late as May 26. It was further found that seed from infested fields, upon germination, is capable of conveying the disease to the seedlings. It was demonstrated that the mycelium of the fungus occurs within the seed coats of the cotton seed from which the young plants are attacked.

The study of the effect of foreign pollen on the productivity of *Rotundifolia* grapes was hindered to some extent by the change of the horticultural grounds, but some experiments were continued on the old plantings.

The entomologist devoted all his time to the study of the life history and action of the stomach worm, which is carried on in cooperation with the station veterinarian and the state entomologist. On account of the close relationship of the stomach worm to other parasites of the intestinal tract of ruminants, this project has been extended to include an investigation of the strongyloid parasites. Several post-mortem examinations revealed the presence in the intestines of the hookworm of cattle (*Monodontus phlebotomus*), stomach worm (*Hæmonchus contortus*), a strongyloid worm, named hair worm (*Cooperia punctata*), and the inflated bowel worm (*Æsophagostoma inflatum*). In connection with this study daily examinations were made of the feces of calves and the egg record of the parasites noted. With reference to combating the stomach-worm disease, it was concluded that medicinal treatment is not successful and that changing or rotating pasture lands is the most effective method to eradicate the pest. The entomologist also began work on the temperature relations of insects for the purpose of determining the total temperature required for the passage from one stage to another in the life cycle of a number of species, the studies being principally with *Hippodamia convergens*, *Conotrachelus nenuphar*, *Sanninoidea exitiosa*, and *Aphis brassica*.

During the past year every department of the station carried on work under the Hatch fund. The subjects studied were as follows: Economical use of fertilizers for various crops, systems of rotation, plant breeding, sources of nitrogen in fertilizers, the chemical composition of different substances, starch production, sweet-potato rots,

pecan diseases, animal feeding, entomological problems, and other minor subjects.

The station was also active during the year in pursuing cooperative work with this Department, which included a study of certain insect pests of cereal and forage crops, tests of newly introduced forage plants, sweet-corn breeding, making a plant disease survey of the State, the trial of methods of preserving timber with creosote, the use of hog-cholera serum, and the promotion of the dairy industry of the State.

The following publications of the station were received during the year: Bulletins 137, Hookworm disease of cattle; 138, Analyses of commercial fertilizers; 139, Milk fever (parturient paresis), its prevention and successful treatment; 140, Some conditions influencing cotton production; 141, Treatment of plant diseases and injurious insects in South Carolina; 142, Stomach-worm disease of sheep and young cattle; 143, Some injurious orchard insects; 144, Celery; 145, Fertilizer experiments with cotton; and 146, Sweet-potato work in 1908.

The income of the station during the past fiscal year was as follows:

United States appropriation, Hatch Act.....	\$15,000.00
United States appropriation, Adams Act.....	11,000.00
Farm products, including balance from previous year--	5,077.18
Total	31,077.18

A report of the receipts and expenditures for the United States funds has been rendered in accordance with the schedules prescribed by this Department and has been approved.

The separation of the station work from that of the college and the change in the equipment incident thereto is working out satisfactorily, and will facilitate to a great degree the progress of the many different lines of work upon which the station is engaged.

SOUTH DAKOTA.

South Dakota Agricultural Experiment Station, Brookings.

South Dakota State College of Agriculture and Mechanic Arts.

J. W. WILSON, M. S. A., Director.

The work of the South Dakota Station during the year did not indicate any important changes, and the personnel of the staff, with the exception of several new assistants, remained the same as the year before. The state appropriation for substations during the past year was \$4,500. A dairy barn with two silos attached was in process of construction.

Satisfactory progress was made in the various Adams fund projects. In the work on rotations as related to soil fertility, the rota-

tions previously used were continued and a new long time rotation to run for twenty-four years, with alfalfa, corn, peas and oats, was introduced. Chemical and physical analyses in the samples of soil were made and a special laboratory was fitted up for the work. The work in fruit breeding was conducted on an extensive scale. New crosses were made of the sand cherry with plums, apricots, and peaches. Two promising varieties for the north central region have resulted from crossing the sand cherry with plums. Investigations were also carried on with apples, grapes, peaches, and roses. The work on roses has resulted in doubling the wild rose.

The digestion experiments with sheep were discontinued and a report was made on the work.^a Digestion coefficients for Dakota-grown grains and forage plants were determined, and this same line of work is now continued with horses. The study of lumpy jaw included histological and bacteriological studies of the disease to determine its cause. Preliminary work was done on the project relating to the effect of alkali waters in dairying.

With Hatch funds, the agronomy department of the station tested systems of farming, bred corn for protein and oil content, and carried on similar work at the substations. The variety tests of corn conducted in cooperation with this Department were completed, a 5-year period being closed. At the Highmore substation, the soil fertility work included systems of farming and rotations of three or more years containing one leguminous crop, cultivated versus uncultivated crops, fallow, different methods of plowing, and variety tests with barley, oats, and durum and spring wheats. The clovers and alfalfas collected abroad by the horticulturist, after their culture in the greenhouse, were transferred to the field. Preparations were also made to begin work at the Eureka and Cottonwood substations.

The horticultural department continued its work with a large collection of alfalfa from Siberia and other countries, with a view to securing a strain or variety erect in habit and with abundant seed not easily shaken off the plant. The chemist in cooperation with this Department worked with sugar beets to produce a high percentage of sugar by selection of mother beets and to find hardy strains adapted to South Dakota.

The botanist of the station did considerable work in weed spraying, giving special attention to mustard, and published a bulletin on this subject. An investigation of the cytology of rusts was made, and in this connection the botanist worked during the summer in the laboratory at Madison, Wis.

In animal husbandry, steers of different ages were fed on the same grain ration to determine the most profitable age of feeding, and a

^a South Dakota Sta. Bul. 114.

record was made of the gains of hogs following these steers. The experiment in breeding and feeding sheep, planned for six years, was continued. Western ewes were bred to Cotswold, Hampden, Oxford, Shropshire, Southdown, and Rambouillet rams. The wool of the lambs was graded each year and an exact record of crosses and results in the wool and lambs was kept. Tests in feeding lambs with different kinds of grain and rape versus no grain in the ration were also followed.

The station cooperates with this Department in growing sugar beets, dipping cattle affected with mange, in testing varieties of corn, in introducing grasses and forage plants suitable for the Northwest, distributing blackleg vaccine, daily weather forecasts, and in growing different varieties of alfalfa to determine their hardiness and habits of growth. With the exception of lectures at farmers' institutes no extension work was carried on by the station officials.

The publications received from this station during the past year were as follows: Bulletins 105, Stock food for pigs; 106, Sugar beets in South Dakota; 107, Sheep scab; 108, New hybrid fruits; 109, Rusts of cereals and other plants; 110, Progress in variety test of oats; 111, A study of South Dakota butter with suggestions for improvements; and 112, The killing of mustard and other noxious weeds in grain fields by the use of iron sulphate; and the Annual Report for 1908.

The income of the station during the past fiscal year was as follows:

United States appropriation, Hatch Act.....	\$15,000.00
United States appropriation, Adams Act.....	11,000.00
State appropriation	2,000.00
Farm products	3,169.36
Miscellaneous.....	2,948.91
Total	34,118.27

A report of the receipts and expenditures for the United States funds has been rendered in accordance with the schedules prescribed by this Department and has been approved.

The work at the South Dakota Station is evidently growing rapidly in appreciation and in demands upon it. The station is in need of increased funds to carry on its work to best advantage. It is making good and economical use of the funds it now has, and has demonstrated its usefulness.

TENNESSEE.

Tennessee Agricultural Experiment Station, Knoxville.

Department of the University of Tennessee.

H. A. MORGAN, B. S. A., *Director*.

Steady progress marked the course of the Tennessee Station during the year. The resignations and new appointments did not interfere to any great extent with the organization of the staff or the efficiency of the station in general. J. N. Price resigned as dairyman, and his work was combined with that of the animal husbandman, F. C. Quereau, and F. H. Denniss was appointed assistant dairyman. W. E. Grainger, fertilizer and food chemist, and H. H. Hampton, soil chemist, resigned and W. K. Hunter and W. H. Maynard were appointed assistant chemists and S. Levitt, of the Bureau of Chemistry of this Department, soil chemist. Near the close of the year F. C. Quereau resigned to become assistant director of the rice substation at Crowley, La. According to an appropriation bill passed by the legislature, \$10,000 is set aside for maintaining the substation at Jackson, \$5,000 for crop experiments in middle Tennessee, and \$7,500 for the station at Knoxville.

The West Tennessee substation, for which provision was made in 1907, was definitely located during the year near Jackson, in Madison County, about 175 acres of land having been donated by the county. Substantial frame buildings have been erected, and experiments have been begun in the feeding of beef animals and in the cultivation of various field, fruit, and garden crops. The station farm contains 3 types of soil—bottom land, white clay, and sandy soil. The land is admirably suited for experimental and demonstration work, and some of the fields present the opportunity of studying the problem of economical soil improvement. An orchard has been set out, and it is planned to maintain a dairy herd and to carry on feeding experiments with steers.

Progress was reported in a number of Adams fund projects on which the station is at work. The study of soil biology included a study of the soy-bean bacterium, with special reference to discovering the reason why wheat after soy beans is not productive, and an investigation of methods of studying the germination and growth of seeds in soil with bacterial control. The anthracnose project was continued, and a new resistant strain of alfalfa secured in connection with this work is now to be tested in a practical way in different localities. In the humus project different types of soil are being used in experiments conducted in a series of about 100 cylinders 4 feet deep, and sets of cans from 1 to 6 feet deep. Pot experiments are also being arranged to determine the rate of decay and formation of humus.

A special refrigerating plant was installed in the basement of the new agricultural building for the purpose of temperature control in different kinds of entomological and bacteriological work. Two species of ticks other than cattle ticks are being studied to determine whether or not they transmit Texas fever. This work is partly in cooperation with the Bureau of Entomology of this Department. The study of the peach borer was continued, and a special orchard has been set out for use in further studies.

The work conducted with the Hatch fund included several important lines. The division of botany has developed a new early variety of cotton which is now being distributed. Attention was also given to *Rhizoctonia* on crimson clover and alfalfa, which is giving trouble in the State.

Experiments with soils, fertilizers, and farm crops were carried on by the departments of chemistry and agronomy in various parts of the State, and a bulletin on this work was issued during the year. Cropping systems are being worked out and the field work with leguminous and other crops was followed up by laboratory studies. It has been shown that leguminous crops may be profitably substituted in the rotation for corn. Special emphasis is laid upon the culture of soy beans, and a bulletin comparing the soy bean and the cowpea was published during the year. Chemical studies of manures and rock phosphate were made, with accompanying field tests. Thus far no beneficial action of the phosphate from combination with manures has been discovered.

The work of the dairy department consisted of feeding experiments to determine the most satisfactory and economical rations for dairy cows under local conditions. The results of part of this work were published in bulletin form, with the general statement that a well-balanced ration can be produced on the farm at much less cost than it can be purchased. This department cooperated with the Bureau of Animal Industry.

Recent work in animal husbandry has included feeding experiments on the use of soy beans, alfalfa, and cowpeas, instead of cotton-seed meal. Emphasis is further laid upon studies with barley and soy beans as substitutes, at least to a certain extent, for corn. This work is carried on to find means of meeting the increased prices in some of the more common feeding stuffs. These investigations are coordinated with work in agronomy.

The station is extensively engaged in cooperative work. A report of the cooperative work with farmers carried on under a state appropriation in middle Tennessee for 1907-8 was recently issued. The principal lines of investigation are in connection with field crops and the production and use of hog-cholera serum. Cotton and cereal studies are pursued in cooperation with the Bureau of Plant Industry,

and field work in dairying with the Bureau of Animal Industry of this Department.

The publications of the station received during the year were as follows: Bulletins 79, The relation of steer feeding to farm economics; 80, Home-grown rations in economical production of milk and butter; 81, Tick eradication, the life history and habits of the North American fever tick, with special reference to eradication; 82, The soy bean, a comparison with the cowpea; 83, Comparison and improvement of dairy herds in Tennessee; 84, Sheep and lambs in Tennessee; 85, Prevention of hog cholera; 86, Experiments with soils, fertilizers, and farm crops; two press bulletins; and the Annual Report for 1906.

The income of the station during the past fiscal year was as follows:

United States appropriation, Hatch Act.....	\$15, 000. 00
United States appropriation, Adams Act.....	11, 000. 00
Fees	1, 000. 00
Farm products.....	8, 058. 55
Total.....	35, 058. 55

A report of the receipts and expenditures for the United States funds has been rendered in accordance with the schedules prescribed by this Department and has been approved.

The work of the Tennessee Station has been materially strengthened in recent years, and is evidently making a distinct impression on the farmers of the State. The conditions in different parts of the State are studied carefully and an effort is made to meet the needs of the State's agriculture in a practical way. With increased resources in sight the station has a quite promising outlook.

TEXAS.

Texas Agricultural Experiment Station, College Station.

Department of the State Agricultural and Mechanical College of Texas.

H. H. HARRINGTON, LL. D., *Director*.

The personnel of the Texas Station underwent few changes during the year, and the work of the various departments was carried on without the interruptions generally incident to resignations and new appointments. Since the close of the fiscal year, however, two new appointments have been made: R. H. Pond as plant pathologist, and W. Newell, recently state entomologist of Louisiana, as entomologist of the station. C. E. Sanborn, who was entomologist for a short time during the early part of the fiscal year, was succeeded by G. W. Herrick, who left the station near the end of the fiscal year to take up work at the New York Cornell Station.

The State made an appropriation of \$50,000 for the establishment and maintenance for two years of four or more branch stations. Sev-

eral such institutions have already been established in different sections of the State and liberal donations in the way of lands and buildings were made to each of them. The State also appropriated \$7,000 for the maintenance and support of the Beeville and Troupe substations. The new agricultural building (Pl. IV, fig. 2), costing about \$45,000, will be completed January 1, 1910, and will afford ample working space for the several departments of the station.

The Adams fund investigations, described in previous reports, have nearly all made progress during the year and some of them have reached a stage justifying a partial or a preliminary report of the data obtained. In the breeding work with dewberries, raspberries, and other species of *Rubus*, from 400 to 500 crosses and selections are under observation. The object of the work in general is the elimination of spines and the improvement of vigor, growth, and quality. The project on the digestibility of some Texas feeding stuffs was partly reported upon in a bulletin issued during the year, and a preliminary report on nitrification was also issued, in which the conditions influencing the production of available nitrogen as observed are set forth. In the soil studies up to this time, attention was chiefly given to phosphoric acid, humus, and nitrogen, but studies on potash and soil acidity have now been taken up in addition. The data thus far secured in the investigation of swamp fever in horses and mules were also published. It was found that the infection which occurs in the blood can be conveyed by subcutaneous or intravenous injection, and that the specific germ seems to be ultra-microscopic. Attempts to convey the disease to cattle, sheep, goats, pigs, or dogs were unsuccessful. The project on the nitrogen-fixing bacteria of leguminous plants has progressed, and a preliminary report upon it has been made.

The more important of the extensive and varied lines of work followed in addition to the Adams fund investigations are here briefly outlined. The horticulturist is carrying on work in forestry by studying the planting of pines and the value of wind-breaks. Among horticultural lines, crossing experiments with tomatoes are in progress.

The department of animal husbandry is making a comparison of the cost of pork production in well-bred or improved types of hogs and in scrubs or razorback hogs. Experiments are also being conducted to determine the comparative feeding values of corn, rice bran, and Spanish peanuts in pork production.

The chemist is carrying on 65 cooperative fertilizer experiments, making analyses of feeding stuffs and miscellaneous materials, and is studying pecan oil, paints, the effect of heating on cotton-seed meal, and the composition of some typical Texas soils.

The agriculturist was engaged in testing varieties of southern field crops and studying methods of soil preparation and tillage, rotations, drought-resistance crops, alfalfa culture, and ways and means of combating the boll weevil. In addition to these lines of work the agriculturist carried on a large correspondence about agricultural matters with farmers of the State and was engaged in extension work consisting of lectures to farmers and before schools.

The department of botany and mycology had under investigation a disease of the onion, known as pink root, a disease of cactus, and several diseases of citrus plants.

The veterinarian did work on Texas fever and hog cholera. The Texas-fever work is resulting in the saving of a large proportion of the cattle inoculated against the disease. In the hog-cholera work serum treatment was tested and means were sought for reducing the cost of this treatment.

The publications received from the Texas Station during the year were as follows: Bulletins 104, Digestion experiments; 105, Notes on forest and ornamental trees; 106, The production of active nitrogen in the soil; 107, Commercial fertilizers and poisonous insecticides in 1907-8; 108, Winter bur clover; 109, The estimation of cotton-seed hulls in cotton-seed meal; 110, Steer-feeding experiments; 111, Texas fever; 112, Nature and use of commercial fertilizers; 113, Spray calendar; 114, Composition of white lead and paints; 115, Fertilizer tests with onions; 116, The foul brood of bees and the foul-brood law; 117, Commercial feeding stuffs in 1907-8; 118, Report of progress with citrus fruits; 119, Infectious anemia of the horse; and 120, Corn and cotton experiments for 1908.

The income of the station during the past fiscal year was as follows:

United States appropriation, Hatch Act.....	\$15, 000. 00
United States appropriation, Adams Act.....	11, 000. 00
State appropriation for substations.....	7, 000. 00
Miscellaneous.....	1, 086. 47
Total	34, 086. 47

A report of the receipts and expenditures for the United States funds has been rendered in accordance with the schedules prescribed by this Department and has been approved.

With the many and varied lines of investigation in progress and with an improvement affecting its organization, the Texas Station has before it the prospects and possibilities of accomplishing much of importance and value to the agriculture of the State and of the entire Southwest.

UTAH.

Agricultural Experiment Station, *Logan*.

Department of the Agricultural College of Utah.

E. D. BALL, Ph. D., *Director*.

There was no great change in organization or policy at this station during the year. For the first time in a number of years there were no changes in heads of departments. Robert Stewart, chemist of the station, was granted leave during the year for graduate study, and at the end of the year R. S. Northrop, horticulturist, resigned to go into private business. J. R. Horton, assistant entomologist, accepted a position in the Bureau of Entomology of this Department, and was succeeded by E. P. Hoff. E. H. Walters was made assistant chemist and P. V. Cardon assistant agronomist. R. A. Hart was transferred from drainage investigations of this Office to the station staff to assist in field work in drainage.

Appropriations to the college and station aggregating \$202,100 were made by the last legislature. This is nearly double the total amount granted two years before, and represents the full amount requested. The college received \$132,000 for maintenance, \$20,000 for remodeling the women's building, \$3,500 for a veterinary hospital, \$2,500 for a stock-judging pavilion, and \$600 for an incubator cellar, the last two of which were built during the year. The grant for farmers' institutes was increased from \$3,000 to \$10,000. The station was given \$5,000 for publications, \$10,000 for dry-farming investigations, \$11,000 for fruit investigations, and \$7,500 for irrigation and drainage investigations.

The Adams fund projects were carried on without material change during the year. The poultry investigations were extended and considerable additions made to equipment for the work, consisting of additional colony houses and brooders, egg-turning tables, and pedigree breeding apparatus. The construction of an additional incubator cellar for experimental purposes was begun. The results of the poultry investigations have brought out a number of important facts regarding the management of incubators (especially carbon dioxide and water supply), methods of feeding, and transmission of egg-laying qualities. The chemical study of the formation and movement of nitrates in the soil was continued, and a cooperative arrangement was made with the Bureau of Plant Industry of this Department for bacteriological investigation of the subject. The investigations on grasshoppers have been practically completed and a report on the subject is in preparation. Some further work on leaf hopper, confirming previous conclusions that this insect is responsible for the so-called blight of sugar beets, was carried on. Owing to unfavorable

weather conditions little work was done on the codling moth. Investigations on the life history of the alfalfa leaf weevil and means of control, and studies of the amount of arsenic necessary to kill orchard trees, were begun.

In addition to the Adams fund investigations, the horse-breeding work has been continued with gratifying results. The stallion registration law passed at the previous session of the legislature has been enforced and the standard of the horses of the State is rapidly advancing.

The experimental work in dairy lines was limited, owing to the proposed change from grade to pure-bred stock. Cooperative work in testing dairy herds was carried on with the farmers and creamery men in a number of localities, and is resulting in a gradual betterment of dairy herds. Two more breeds of sheep were added to the livestock equipment and the sheep-feeding experiments were continued.

Investigations in arid farming were continued, and extended to include more cooperative work with different divisions of the Bureau of Plant Industry of this Department. Scientific work was discontinued at all of the substations except the one at Nephi. Forty acres more of land have been secured adjoining the original plat and all of the work in plant breeding transferred to this place. A large number of varieties of wheat and other farm crops are being tested and pedigree breeding methods employed on the most valuable varieties. Improved strains of winter oats and barley have been developed and are now being distributed, and considerable improvement has been made over the wheats formerly used in arid farming. The arid farming interests of the State continue to develop with wonderful rapidity. Thousands of acres are being taken up annually, and in some of the more fertile locations homes are being established on the farms.

The station took over the work in sugar-beet breeding and testing formerly carried on in cooperation with the Bureau of Plant Industry, and more thorough methods of pedigree breeding are being employed.

Irrigation experiments were continued in modified form on the Greenville farm in cooperation with this Office. The larger part of the work was, however, transferred to cooperative experiments with farmers in different sections of the State in order to test the water requirements of different soils. Orchard irrigation was also taken up in cooperation with private orchardists, and an extended investigation is planned to ascertain the effect of different amounts of water on fruit produced, quality, size, color, size of pit, keeping quality, and other factors of successful fruit production.

The drainage investigations, also in cooperation with this Office, were continued, several of the projects having been closed up and turned over to the communities in satisfactory condition. One or two

new projects were started and much assistance was given to private individuals and communities in ascertaining the feasibility of establishing drainage systems.

Investigations on the "big head" of sheep were continued in cooperation with the Bureau of Animal Industry of this Department.

The following publications were received from this station during the fiscal year: Bulletins 103, Milling qualities of wheat, and 104, The storage of winter precipitations in soils, and the Annual Report for 1906.

The income of the station during the past fiscal year was as follows:

United States appropriation, Hatch Act-----	\$15, 000. 00
United States appropriation, Adams Act-----	11, 000. 00
State appropriation-----	9, 024. 92
Farm products, including balance from previous year--	4, 631. 48
Miscellaneous, including balance from previous year--	987. 50
Total-----	40, 643. 90

A report of the receipts and expenditures for the United States funds has been rendered in accordance with the schedules prescribed by this Department and has been approved.

The more settled condition of affairs which prevailed at this station during the year was evident in the increased efficiency of both the scientific and the practical work. While making valuable contributions to many of the great practical problems of Utah agriculture, the station is not neglecting the fundamental scientific inquiries necessary to establish sound practice.

VERMONT.

Vermont Agricultural Experiment Station, *Burlington.*

Department of University of Vermont and State Agricultural College.

J. L. HILLS, Sc. D., *Director.*

The lines of work of the Vermont Station have not changed materially during the year, neither have there been any changes in buildings nor striking additions to the equipment. On the station staff, however, many changes have occurred. C. R. Pettis, consulting forester, was succeeded by A. F. Hawes as forester of the station on April 1. The place of N. J. Giddings, assistant botanist, who became plant pathologist at the West Virginia Station, was filled by B. F. Lutman. R. E. Vaughan, assistant horticulturist, was called to the chair of agronomy in the Mount Hermon School, Mount Hermon, Mass., and was succeeded at the station by J. W. Wellington. H. A. Edson was advanced from assistant botanist to bacteriologist. Since the close of the fiscal year several other resignations have taken place. L. R. Jones, botanist of the station for twenty years, has resigned to take effect February 1, 1910, to accept the position of

plant pathologist at the Wisconsin Station. A. P. Bigelow, assistant in dairying, has gone into commercial work, and P. A. Benedict was appointed assistant chemist. S. Hargreaves was appointed station gardener, vice H. V. F. de Thestrup, and E. H. Powell, treasurer of the station for seventeen years, was succeeded by C. P. Smith. The State has definitely provided for the printing of publications, which will be a material assistance.

The projects carried on under the Adams Act have progressed satisfactorily during the year. The work on the bacterial rot of muskmelons and the anesthesia of dormant plants for forcing purposes is about ready for the final report. The study of potato diseases has resulted in gaining important knowledge regarding the resting-spore stage of *Phytophthora*. A large amount of data has been collected on the effect of feeding different amounts of digestible protein to cows for a long period. Other investigations recently taken up under this fund are a study of the causes, conditions, and prevention of the damping off of coniferous seedlings; an investigation of the fundamental processes relative to the storage of sugars and other carbohydrates in the wood and inner bark of the maple, the forcing of plants with carbon dioxide, and a study of the relation of size of seed to the character of the offspring.

The lines of work supported with other funds are also progressing and results are accumulating. The data secured in the cooperative investigation with the New York Experiment Station on the soft rot of vegetables are now being published. The forestry department is studying the rate of growth of timber under different conditions, methods for the prevention and control of forest fires, and related questions. This department will distribute in the spring of 1910 through the station 200,000 white-pine seedlings, and has on hand about 1,000,000 younger seedlings for later distributions.

The dairy husbandman, among other lines of work, is making tests of dairy cows in cooperation with three associations in the State, but the station devotes little time and money to this work, the expense being borne by the owners.

The station is cooperating with this Department in breeding Morgan horses and in studying, since 1904, disease resistance in potatoes. Cooperative work was also carried on with farmers in the eradication of quack or witch grass and in potato disease resistance.

Some extension work was carried on by the director. Exhibits were made at fairs during the year, some members of the staff addressed farmers' institutes, and a successful farmers' week was held in the late winter.

The following publications were received from the station during the fiscal year: Bulletins 135, Commercial fertilizers; a quarter century of fertilizer inspection, soil deterioration, and soil humus;

136, Abstract twentieth report, 1906-7—plant disease, horticulture, weeds, insects; 137, Abstract twentieth report, 1906-7—crops, forestry, stock feeding, dairy husbandry; 138, Commercial feeding stuffs; the viability of weed seeds in feeding stuffs; 139, Preliminary statement regarding the forestry problems of Vermont; 140, Commercial fertilizers; and 141, Apple culture in Vermont; Circulars 1, The bulletins of the fertilizer control; and 2, The gipsy and brown-tail moths.

The income of the station during the past fiscal year was as follows:

United States appropriation, Hatch Act-----	\$15, 000. 00
United States appropriation, Adams Act-----	11, 000. 00
State appropriation -----	1, 000. 00
Fees -----	3, 084. 06
Miscellaneous-----	100. 00
Total-----	30, 184. 06

A report of the receipts and expenditures for the United States funds has been rendered in accordance with the schedules prescribed by this Department and has been approved.

The Vermont Experiment Station with its practical and scientific lines of work, pursued either alone or in cooperation, is solving problems of importance to the agriculture of the State, and is yearly becoming a more efficient and valuable aid to the farmer.

VIRGINIA.

Virginia Agricultural Experiment Station, Blacksburg.

Department of Virginia Agricultural and Mechanical College and Polytechnic Institute.

S. W. FLETCHER, Ph. D., *Director*.

At the close of the year, N. S. Mayo, recently of the Cuban Station, was appointed animal husbandman, vice W. J. Quick, and H. E. Allen was appointed to succeed A. P. Spencer as assistant in the same department. E. B. Fred, of the staff, is on leave taking advanced work in soil bacteriology in Germany. W. L. Mallory was appointed assistant in animal husbandry and agronomy for work on Adams fund projects. The dairy division was installed during the year in its quarters in the basement of the new agricultural building. The equipment of this division is now very much better than formerly, and its efficiency in experimental lines is consequently in position to increase.

Satisfactory progress was made in a number of the Adams fund projects. The horticulturist has under way a large breeding study for the purpose of determining how late blooming varieties of apples may be obtained for use in Virginia, where late frosts often injure the apple crop. A study of the history of fruit bud formation in

the common orchard fruits has been made, preliminary to an investigation relating to the effect of soil environment on fruit bud formation. The fermentation studies, showing the possibility of controlling cider fermentation by means of selected yeasts, have been in part reported upon, and the final results will appear in the report for 1909. The study of problems in the biology of canning, pertaining mainly to apples, potatoes, beans, and corn, has been begun. The study of the cause of self-sterility in fruits was continued, principally with pears. This work has been transferred from the field to the greenhouse, and the accumulated data are being summarized for publication.

The study of the fixation of phosphoric acid in the soil, by the department of chemistry, has now been carried on for four years in the laboratory, the greenhouse, and the field, and a progress report will soon be published.

The project on the effect of different methods of treatment and of grazing on pasture grasses is being studied on 20 acres of plats at the station and at a number of different places in the State. In connection with this work an effort is made to determine means for the eradication of "broom sedge" from pastures.

In the study of soil bacteria good progress was made. At the station, inoculated soy beans yielded an increase of 1 ton of hay and 10 bushels of seed per acre, as compared with a similar plat of uninoculated soy beans. Other results gave a reasonable basis for the estimation that the inoculation of soils from legume nodules will increase the nitrogen content of the soil without the presence of the host plant. By means of pot experiments it was found that the presence of denitrifying organisms in the soil decreased plant growth, and that denitrification was more common in open loam than in clay soils. The application of fresh manure increased the denitrifying activity to a greater extent than did the use of new straw.

The department of animal husbandry made a systematic study of the curative effect of good feeding and care in the eradication of tuberculosis from dairy and breeding herds. Careful records were kept of all the animals and they were examined and tested by the veterinarian from time to time. Some of the animals will be slaughtered soon and post-mortem examinations will be made.

Work carried on with other funds included a study of the lime resources of the State and of the comparative value of ground limestone and burned lime by the department of chemistry. Studies of inheritance in garden vegetables with particular reference to Mendel's law, varietal studies of orchard fruits, fertilizer experiments with apples, and a culture test of basket willows in cooperation with the forest service were conducted by the department of horticulture, and continued efforts to improve the crops most commonly grown in

Virginia, and experiments with grasses, forage, fertilizer, and crop rotations were made by the department of agronomy. The dairy department studied the production of sanitary milk and the efficiency of farm separators, while the department of animal husbandry gave special attention to feeding tests in order to determine the most economical use of silage in feeding steers and the comparative value of various substitutes for milk in feeding calves.

The station cooperates freely with other agencies conducting agricultural work in the State. Three projects are carried on in cooperation with the United States Department of Agriculture, two with the Virginia Truck Experiment Station, and plans are being made to cooperate with the state department of agriculture. During the year all station field work and equipment was segregated from that of the college, which is resulting in a more effective and more economical management for both.

The six local experiment stations established by the State are under the joint control of the station and the Bureau of Plant Industry of this Department. These stations, located in the several tobacco districts of the State, were originally established solely for experiments with tobacco, but their scope has now been extended to include crops grown in rotation with tobacco. E. H. Mathewson, of the Bureau of Plant Industry, is in immediate charge at these local stations, which are maintained by an appropriation of \$5,000 each from the State and from the Bureau of Plant Industry. Efforts are being made to arrange cooperative experiments with farmers and to encourage the establishment of more local stations by the State. Most of the members of the station staff have assisted at from 4 to 15 farmers' institutes during the year, and in addition the college and the station jointly conducted two institute trains.

The plan has been adopted of making the bulletins short and non-technical, and of reserving the details and technical matter for the annual report.

The following publications were received during the year: Bulletins 174, The cultivation of potatoes; 175, Cooperative tobacco investigations; 176, Hog feeding; 177, Inheritance in tomato hybrids; 178, Causes of the heavy loss of lambs in 1908; 179, Homemade soluble oils for use against the San José scale; 180, The blue grass of southwest Virginia; and 181, Wormy apples and how to prevent them—Results of spraying for codling moth in 1908; Circulars 1, Sugar beets in Virginia; 2, How the experiment station can be of service to the farmers of Virginia; 3, Dates of seeding winter grains; 4, Selecting seed corn; 5, Sugar beets in 1908; 6, Improving the corn crop; and 7, Fighting insect pests and diseases of orchard, field, and garden crops; and the Annual Report for 1908.

The income of the station during the past fiscal year was as follows:

United States appropriation, Hatch Act-----	\$15,000.00
United States appropriation, Adams Act-----	11,000.00
State appropriation-----	5,000.00
Farm products-----	694.10
Miscellaneous-----	556.54
Balance, state appropriation and miscellaneous-----	5,155.18
Total-----	37,405.82

A report of the receipts and expenditures for the United States funds has been rendered in accordance with the schedules prescribed by this Department and has been approved.

The work of the Virginia Station, under its more stable organization, continues to grow in popular favor. The mailing list has increased from 13,000 in 1907 to 23,000 in 1909, and the correspondence with farmers in 1909 was nearly twice as extensive as in the previous year. Interest in the station and its work is steadily increasing.

Virginia Truck Experiment Station, Norfolk.

Cooperating with the Virginia Agricultural Experiment Station and the United States Department of Agriculture.

T. C. JOHNSON, B. S. Agr., M. A., *Director*.

At the Virginia Truck Station a laboratory building and barn and a residence for the director were completed during the year. C. S. Heller was appointed to the station staff as assistant horticulturist, and C. H. Popenoe, of the Bureau of Entomology of this Department, was detailed for certain cooperative work.

The work of this station, as its name implies, relates to truck crops and includes fertilizer experiments, plant breeding work, seed tests, studies of insects and plant diseases, the comparison of different insecticides and fungicides, and similar lines of work.

Cooperative work was carried on with the Bureau of Plant Industry in the study of malnutrition of truck crops, the sweet potato, and the peanut; with the Bureau of Entomology in the study of cabbage and spinach insects; and with the Virginia Station on certain fungus diseases of spinach.

The director of the station cooperated with the state department of agriculture in conducting farmers' institutes in the truck-growing portions of the State.

Two circulars were received during the year: Circulars 1, Treatment for scab and early blight on potatoes. Mildew on cucumbers and cantaloups; and 2, Preliminary report on potato germination troubles in 1909.

The income of the station during the past fiscal year was as follows:

State appropriation	\$5,000
State board of agriculture and immigration.....	5,000
Total.....	10,000

The location of the Virginia Truck Station is most favorable to the establishment of many lines of work with all kinds of vegetable and garden crops, and careful investigation can not fail to lead to valuable results.

WASHINGTON.

Washington Agricultural Experiment Station, *Pullman.*

Department of the State College of Washington.

R. W. THATCHER, B. S., M. A., *Director.*

Reorganization, with a view to the more complete differentiation of college and station work, was perfected during the year, and the activities of the station were considerably enlarged, with consequent changes in personnel. H. B. Humphrey, formerly of Leland Stanford Junior University, was appointed plant pathologist during the year; C. C. Thom, of Guelph, soil physicist, with E. L. Peterson as assistant; W. T. McDonald, formerly of the Oklahoma Station, animal husbandman; G. A. Olson, of the Wisconsin Station, and W. L. Hadlock, assistant chemists; A. Carlyle, assistant cerealist; Rex N. Hunt, assistant botanist; and W. H. Hein, assistant horticulturist. W. H. Lawrence, superintendent of the Puyallup substation, was appointed plant pathologist to study plant diseases in western Washington. A library assistant for the station was provided. The director of the station was made superintendent of farmers' institutes, with O. M. Olson as deputy.

Extension work has largely been turned over to a new department for this purpose and is participated in only incidentally by station men. New lines of extension work during the past year were farming demonstration trains, which were very largely attended and enthusiastically received, and demonstration farms which are being established at representative points throughout the State, under the direction of a supervisor of demonstration farms (H. W. Sparks) appointed for this purpose. This work is supported by a biennial state appropriation of \$17,500. Biennial appropriations of \$4,000 and \$2,500 were made by the last state legislature for cereal investigations and cooperative experiments in dry farming and irrigation, respectively.

A new barn was built, the greenhouse was enlarged, the additional farm land recently acquired was brought under cultivation, and a considerable amount of live stock was added to the station equipment

during the year. The last legislature made liberal appropriations to the college for building purposes and a number of new buildings are being erected. This legislature also appropriated \$29,600 for the maintenance of the Puyallup substation for the current biennium.

Substantial progress was made in several of the Adams fund projects. The investigations on improvement of cereals and soil moisture were extended in scope during the year with state aid, and a progress report on the first is ready for publication. Investigations on extermination of spermophiles were practically completed and a report is being prepared. Studies of blackberry and raspberry hybrids were prosecuted with good results. Some work was also done on a number of other projects, including nutrition and prolificacy of swine, tomato blight, soil toxicity, starch production by potatoes, hemaglobinemia in cattle, and effect of parasitism on the host insect. A new project—the function of sulphur as a plant food—has been taken up, and the study of bacterial diseases of the blackberry and raspberry has been transferred to state funds. The hybrid wheats which have been developed at the station have been given large field trials and have proved remarkably successful, farmers' reports showing an average of 15 per cent increase in yield over other varieties. An important relation of soluble and insoluble phosphates of the wheat kernel to the baking strength of the flour and physical quality of the grain from it has been discovered and is being further studied.

Adams fund projects received additional support during the year as follows: The cereal work was supplemented by a state appropriation of \$2,000, which was expended largely in the purchase of improved machinery for planting and threshing the grain, and an assistant cerealist was added to give his entire time to these investigations. For the soil moisture work special equipment was installed at the irrigation station at Sunnyside, and measurements of absorption and evaporation of soil moisture were inaugurated and an assistant soil physicist was appointed during the last part of the year; special chemicals and equipment for the soil toxicity work were added; and the swine breeding work was aided by the purchase of two litters of young sows of uniform breeding which are to serve as a basis of future study.

Among the more important lines of investigation aside from the Adams fund projects enumerated above, were the following: Crop rotations and methods of culture to replace summer fallow, variety tests and improvement by selection of corn, tests of Canada field peas, methods of applying manure, variety tests and improvement of forage crops, a succession of forage crops for pigs, soy beans and cowpeas for summer pasture, lime-sulphur wash as a fungicide and insecticide, bitter rot of apples, grain smut, plant disease survey of the State, winter injury to fruits, tests of varieties of grapes, summer

pruning of orchards, apple leaf mining insects, arsenate of lead and other insecticides for codling moth, flies and other insects affecting health, and zoography of Washington. The work of the station has shown that lime-sulphur wash may replace Bordeaux mixture as a practical means of combating many plant diseases.

A fruit demonstration train was operated in the Yakima Valley March 10-12, 1909. Demonstrations were given at 11 stops, with a total attendance of 4,215. A new feature of this train was a flat car equipped with a model orchard in tubs, a large apple tree, and a power sprayer by means of which complete demonstrations of spraying and pruning were given. A "better-farming" special train, sent out March 22-27 through 5 counties in the eastern part of the State, was visited by nearly 10,000 persons on its trip.

The following publications were received from this station during the year: Bulletins 87, Raspberries, blackberries, and loganberries in Washington; and 88, Lime as a fertilizer; Farm practices in applying land plaster in western Oregon and western Washington; Popular Bulletins 6, The milling quality of Washington wheat, I; 7, Summary of the soil survey of the State; 8, Orchard cover crops; 9, Some new hybrid wheats; 10, The construction and filling of silos; 11, Commercial potato growing; 12, The care of milk on the farm; 13, Washington State College spraying calendar for 1909; 14, The planting of the apple orchard; 15, Methods of tillage for dry farming; and 16, The sulphur-lime wash; and the Annual Reports for 1903, 1904, and 1905.

The income of the station during the past fiscal year was as follows:

United States appropriation, Hatch Act.....	\$15,000.00
United States appropriation, Adams Act.....	11,000.00
State appropriation.....	^a 26,500.00
Farm products	1,753.70
Total.....	54,253.70

A report of the receipts and expenditures for the United States funds has been rendered in accordance with the schedules prescribed by this Department and has been approved.

As the above report shows, the Washington Station made decided progress during the year in improving its organization and extending its work. It is now in position to render increasingly efficient service to the agriculture of the State.

^a For two years ended March 31, 1909, and including \$20,000 for the Puyallup substation.

WEST VIRGINIA.

West Virginia Agricultural Experiment Station, *Morgantown.*

Department of West Virginia University.

J. H. STEWART, M. A., *Director.*

The general character of the work and the equipment of the West Virginia Station were not materially changed during the past year. The staff was increased by the appointment of Arthur L. Dacy as assistant horticulturist and Nahum J. Giddings as bacteriologist. The station funds were increased by state appropriations of \$4,000 for truck and horticultural investigations and \$6,000 for orchard and nursery inspection and the control of orchard pests.

Of the nine Adams fund projects undertaken by this station, that relating to variations in the apple and peach was not vigorously prosecuted during the year on account of the continued ill health of the horticulturist. Some orchard planting and other preliminary work was, however, done. Improved laboratory equipment for the study of apple leaf diseases and cucumber mildew was provided and preliminary work on these projects was undertaken. Important additions were also made to the apparatus required in the investigations on the fixation of atmospheric nitrogen, including a motor generator and high-tension transformers. The results of the past year's work on this project are considered fundamental in character and have inspired confidence of ultimate success.

An important outcome of the investigations during the year on the production of sanitary milk has been the perfecting of means of sterilizing milk and cooling and bottling devices, so that a milk of very low germ content and high keeping quality can be obtained. The investigations on the effect of pressure on the preservation of fruits, vegetables, and milk are approaching completion, and a report upon the subject is being prepared. A report of progress in the investigations on excess of mortality among brooder chicks is also being prepared. This will deal more particularly with the influence of methods of feeding and character of rations on the vitality of chicks. The studies on nut insects were practically completed during the year and are ready for publication. Studies on the woolly aphis of the apple are to be continued with a view to working out the complete life cycle of this insect. Important data were collected during the year on the distribution and feeding habits of the short-tail shrew. The studies were also extended to other members of this family.

The principal lines of work aside from the Adams fund projects named above were a study of the soil conditions of the State with special reference to the extent and degree of acidity; tests of the

practicability of replanting to peach and apple trees land which had previously been occupied by a peach orchard which had been destroyed by old age and yellows; a continuation of the fertilizer experiments which have been carried on for a number of years on the station farm; tests of spraying materials for the control of potato blight; tests of varieties and northern *v.* home-grown seed potatoes; control of bitter rot and leaf spot of the apple; fertilizer experiments on apple trees; a preliminary survey of the tomato-canning industry of the State; cooperative fertilizer experiments with special reference to increasing production and ripening of fruit; experiments on the control of brown rot of plums and apple scab; insecticides for San José scale; comparative tests of eastern and western methods for destroying the codling moth; experiments on the destruction of the subterranean form of woolly aphis; tests of arsenical poisons for the control of the cabbage worm, involving a study of the residual poison remaining upon the matured crop; cooperative orchard experiments with varieties, methods of culture, pruning, and grafting; observations on the cost of establishing and bringing to a productive age a commercial apple orchard; and a study of means of maintaining vigor and productivity in chickens reared by purely artificial means. This experiment has been under way without interruption for about ten years. Recent additions to the poultry plant have contributed materially not only to the poultry experiments in general, but has made it possible to study the effect of different types of poultry houses on the health and productivity of laying hens.

As in previous years, the station has carried on a large number of cooperative experiments with farmers in different parts of the State. These included a continuation of tests of methods of exterminating stomach worms in sheep by treating the breeding stock with vermifuges; tests of spraying for the destruction and control of fruit and crop pests; variety tests, culture, and fertilizer experiments with truck crops; demonstrations of the use of legumes and other cover crops for orchards; tests of grasses and leguminous plants as mulch for orchards; tests of varieties, time of planting, methods of culture, and fertilization of tomatoes, with a view to obtaining the best type of fruit for canning; and tests of dairy herds whose owners desire registration in breeders' associations of various kinds.

The soil investigations which have been made by the station show that fully three-fourths of the infertile soils of the State are acid, a condition which can be easily corrected and productiveness restored. The station has also shown that the continued use of acid phosphates does not render soils permanently sour. This is considered an important discovery in view of the extensive use of acid phosphates by farmers and the widely accepted view of their tendency to increase soil acidity.

Fertilizer inspection was carried on as usual by the station. The increased use of fertilizers in the State resulted in a material increase in the income of the station from inspection fees.

Members of the station staff participated to a limited extent in farmers' institutes and other farmers' meetings during the year. A decidedly increased number of farmers sought information and advice along the lines of work carried on by the station.

The following publications were received from this station during the year: Bulletins 117, Tomato notes; and 118, Commercial fertilizers; and a Spray Calendar for 1908.

The income of the station during the past fiscal year was as follows:

United States appropriation, Hatch Act-----	\$15,000.00
United States appropriation, Adams Act-----	11,000.00
State appropriation-----	10,000.00
Fees-----	11,030.81
Farm products-----	7,727.32
Total-----	54,758.13

A report of the receipts and expenditures for the United States funds has been rendered in accordance with the schedules prescribed by this Department and has been approved.

The West Virginia Station is carrying on work in a number of important lines, and should have the cordial support of the agricultural interests of the State in its efforts to strengthen its work and make the results available for practical use.

WISCONSIN.

Agricultural Experiment Station of the University of Wisconsin, *Madison*.

Department of the University of Wisconsin.

H. L. RUSSELL, Ph. D., *Director*.

Through the efficient organization of the work at the Wisconsin Station during the year a vigorous prosecution of the different experiments was made possible. The personnel of the station changed but little with the exception of the appointment of a number of assistants. Since the close of the fiscal year the department of experimental breeding, under the direction of L. J. Cole, has been established for the purpose of carrying on investigations in experimental breeding with special reference to the laws of heredity and the improvement of animal life. The establishment of a department of plant pathology has also been authorized since the close of the fiscal year and L. R. Jones, botanist in the University of Vermont, has been appointed as its head. In addition to these divisions a department of poultry husbandry in charge of J. G. Halpin, a department of agricultural economics in charge of H. C. Taylor, and a department of

economic entomology with J. G. Sanders at the head, have also been organized. E. P. Sandsten, horticulturist, resigned his position since the close of the fiscal year to follow commercial lines of work.

The enlargement of facilities in which the station is partly interested consisted of the completion of a stock pavilion, costing equipped something over \$80,000, the erection of a commodious stock and forage barn on the Hill Farm, 2 miles west of the university, and of land purchased for the establishment of new horticultural grounds.

Among the projects carried on with the Adams fund a study of the leucocytes in milk and their sanitary significance was completed and a report on the work was made in bulletin form. It was found that the same organisms may not only persist in the udder of the cow for long periods but may be present constantly in large numbers.

A report was also made on the investigation of mineral constituents of feeding stuffs and the results thus far secured with inorganic phosphorus, among other things, strongly point to a synthetic power in the animal which enables it to convert inorganic forms of phosphorus into the organic forms required by the body. A depleted phosphorous ration reduced the percentage of ash in the skeleton of pigs nearly one-half as compared with a normal ration. When the low phosphorous rations were supplemented with calcium phosphates no injurious effects resulted. The results have led to the belief that in general grain rations usually fed to hogs are too low in lime for the best development of the skeleton.

The project on the comparison of nutrients from single plant sources and from different plants has shown thus far marked differences in the nutrition of young stock fed on wheat, oats, and corn, singly and in combination. In general the corn-fed lot did better than any of the other lots. A striking difference was observed in the size and vitality of the young produced, the calves from the wheat-fed lot being much lower in weight than those from the corn-fed lot. The results are regarded as indicating that a chemical analysis by itself is insufficient for balancing a nutrient ration properly.

The study of the rôle of acid in Cheddar cheese was carried on in cooperation with the Dairy Division of this Department. The results secured, permitting only a report of progress at the present time, will be tried out on a large commercial scale before a definite announcement is made. The results of analytical studies of some factors aiding in the separation of whey from the curd in the vat were carried on in connection with this work, and the data determined are being arranged for publication.

Work on the disposal of creamery sewage indicated that under ordinary methods the curd and fat remain for 6 to 10 days but that by a modification of the plan a more rapid decomposition is secured.

The study of the influence of soil treatment on the phosphorus content pointed out that the acid soils examined were deficient in available forms of phosphorus. Analytical data showed fixation of mineral phosphorus resulting from applications of phosphorus to the soil, the absence of accumulations of this element under similar conditions in tobacco plantations, and in some experiments a leaching of phosphorus where barnyard manure had been used.

Work carried on with Hatch and miscellaneous funds was also actively prosecuted. The department of agronomy continued its improvement work with oats, barley, and corn. It is thought that one-fourth of all the corn grown in the State is of the Silver King variety which was produced by the station. A Yellow Dent variety, called Golden Glow, has been produced for the more northern parts of the State. The experiments on improved pedigreed strains of barley, adapted to Wisconsin, were completed and the selected strains which yield somewhat better than the Select Oderbruck and Mand-scheuri barleys, and possess superior malting qualities and absolute uniformity, will be distributed through the Agricultural Experiment Association, representing the 1,500 or more graduates of the agricultural courses of the university that cooperate with the station. Experimental work in agronomy was conducted on the farms of 15 different public institutions throughout the State. Cooperative work in the culture of hemp was done with this Department and attention was further given to alfalfa growing and to the use of iron sulphate and salt in the destruction of weeds by spraying.

The horticultural department continued its work with hybrid plums, apples, tobacco, rhubarb, asparagus, and other crops. Through selection in progress for 15 years a very promising strain has been developed from the native plums. Good progress was also made in the crossing of American and English forcing cucumbers. During the season the station method of handling cranberry bogs, under test at Cranmoor, which consists principally in maintaining clean culture, proved to be a very strong factor in the protection of this crop against early frost in the fall. Entomological investigations on cranberry insects were continued in cooperation with the Bureau of Entomology of this Department, being principally directed toward a study of certain phases of the life history of the more important insects, especially the vine and fruit worms.

The department of bacteriology cooperated with the department of chemistry in studying the acid fermentations of milk and the bacteria affecting the flavor of Cheddar cheeses. Milk of a relatively high grade produced on Wisconsin farms examined bacteriologically showed that milk may be kept clean and sanitary by comparatively inexpensive methods. Other lines of work consisted in the study of the bacterial soil flora on plats treated with various combinations

of manure and commercial fertilizers and giving special attention to the production of nitrogen-fixing organisms when plants are not grown. Attention was also given to bacteria connected with animal diseases, especially tuberculosis.

The dairy division in cooperation with this Department worked on the moisture content of the curd during the process of manufacture and also judged butter and cheese sent in from factories.

The department of chemistry in cooperation with the Dairy Division of this Department, completed studies in the ripening of cheese and the results are soon to be published. It was determined that the flavor of the cheeses under examination was due to the presence of volatile esters produced, in part at least, by the decomposition of the carbohydrates in the milk. The results of work on silica and phosphorus in plants seemed to indicate that organic phosphorus and silica differ in different kinds of plants and that the silica compounds appear unstable. A study of the rôle of metabolic water in nutrition was also followed.

In agricultural engineering, the erosion of Portland cement by silage and the King system of ventilation were given attention. The department of soils carried on experimental work on different types of soil in the State with reference to fertilizer requirements and crop adaptation. The liming of acid soils and drainage problems were also considered.

In dairy chemistry, the study of the relation of food to production in the dairy herd was continued and a study was also made of the relation of body weight of the cow to the fat content of milk immediately after calving.

The department of animal husbandry cooperated in the experiments with the dairy herd and conducted investigations on feeding and the cost of producing pigs. Sheep feeding tests and experiments in the preservation and application of farm manures were also followed. This department is charged with the enforcement of the stallion law.

As already pointed out, the Wisconsin Station carried on cooperative work along various lines with the Bureau of Animal Industry, Bureau of Plant Industry, Bureau of Entomology, and the Bureau of Soils of this Department, the Minnesota Experiment Station, and with farmers of the State, especially those belonging to the Wisconsin Agricultural Experiment Association. Among the different activities in this connection may be mentioned cooperative fertilizer experiments, drainage and reclamation work, spraying of orchard fruits, potatoes, and cranberries, crop demonstration work on lands belonging to the various state institutions, the county farms, and the sub-stations in the northern part of the State, tuberculosis post-mortem

demonstration in cooperation with the State Live Stock Sanitary Board, seed distribution, stock breeding, dairy tests, and weed eradication. The inspection and control work of the station includes the licensing of stallions, and feed, fertilizer, nursery, and seed inspection.

The publications received from the station during the year were as follows: Bulletins 159, The cranberry insects of Wisconsin; 164, The King system of ventilation; 165, Vaccination against tuberculosis in cattle with bovovaccine; 166, Disinfection and commercial disinfectants; 167, The University herd, management and records, 1907-8; 168, Spraying potatoes against blight and the potato beetle; 169, Progress in Wisconsin horse breeding, with lists of stallion licenses and transfers for 1908; 170, Licensed commercial feeding stuffs, 1908; 171, Report of the director, 1908; 172, Tests of dairy cows, 1907-8; 173, Milking machine experiments; 174, The conservation of phosphates on Wisconsin farms; 175, A 3-year campaign against bovine tuberculosis in Wisconsin; and 176, The improvement of Wisconsin tobacco through seed selection.

Since the close of the fiscal year a new plan with reference to station publications was put into effect. The results of experimental work directly available for the use of farms will be presented in the regular bulletin series of the station, while the more strictly scientific and technical results will be published in a new series of bulletins entitled Research Bulletins.

The income of the station during the past fiscal year was as follows:

United States appropriation, Hatch Act.....	\$15,000.00
United States appropriation, Adams Act.....	11,000.00
State appropriation.....	18,500.00
Fees	8,469.55
Total	52,969.55

A report of the receipts and expenditures for the United States funds has been rendered in accordance with the schedules prescribed by this Department and has been approved.

The Wisconsin Station has now completed a quarter century of endeavor and progress, having been founded by the State in 1883. The practical and scientific work accomplished by the institution during this period is of incalculable value to the agricultural interests of the Commonwealth and to regions beyond its borders. The record of the station forms an excellent foundation for future achievements and promises the continued support and appreciation of the people.

WYOMING.

Wyoming Agricultural Experiment Station, *Laramie*.

Department of the University of Wyoming.

J. D. TOWAR, M. S., *Director*.

More settled conditions prevailed at this station during the past year than for several years past, thus permitting more systematic development of the work of the station. Progress was made in improving the farm buildings, for which the last state legislature appropriated \$8,000, and in reclaiming the alkali soils on the station farm by means of underdrains (in cooperation with this Office). As a result of the great increase in chemical work a research assistant in chemistry (L. C. Raiford) was appointed shortly after the close of the fiscal year.

Active work was done during the year on four well-defined Adams projects, viz, wool, soil, moisture, alkali, and plants poisonous to sheep. Of these, the wool investigations constitute by far the largest and most important project. Attention was given mainly to a study of the variability of representative wool fibers, with a view to establishing a standard, and the effect of various washes and alkaline substances on the properties of the fiber. The alkali investigations were enlarged in scope and more clearly defined, and now include studies of certain fundamental problems of soil solutions, which will be a part of the special work of the recently appointed research assistant in chemistry. The studies of the distribution of moisture in the soil as affected by varying conditions were continued in cooperation with this Office on the experimental farm at Cheyenne. A reorganization of this project, locating certain phases of it at Laramie, has been undertaken. A beginning was made in the study of plants poisonous to sheep. Certain important preliminary field observations were made and plans for future scientific work were carefully outlined.

In addition to this Adams fund work, the station continued cooperation with the Bureau of Animal Industry of this Department in improvement of range sheep as well as experiments in breeding of polled Hereford cattle; feeding experiments with cattle, sheep, and pigs, mainly to test home-grown rations; composition and digestibility of native forage plants, showing the great feeding value of high-altitude plants; irrigation versus dry farming; tests of adaptability of various crops to Wyoming conditions; and relation of the growth of leguminous plants to the nitrogen of the soil. Various lines of plant-breeding work were resumed following the destruction of the experimental crop by hail the previous year, and preparations were made for permanent plats for soil-fertility investigations.

The station officers gave from one to four weeks of their time to farmers' institute work during the year. This work is maintained with a biennial state appropriation of \$2,000.

The publications of the station received by the Office during the year were: Bulletins 77, Irrigation of barley; 78, Digestion experiments—II; 79, Ration experiments with lambs, 1906-7; and 80, Dry farming in Wyoming; and the Annual Report for 1908.

The income of the station during the past fiscal year was as follows:

United States appropriation, Hatch Act.....	\$15, 000. 00
United States appropriation, Adams Act.....	11, 000. 00
Farm products.....	2, 332. 40
Balance from previous year, farm products.....	320. 55
Total.....	28, 652. 95

A report of the receipts and expenditures for the United States funds has been rendered in accordance with the schedules prescribed by this Department and has been approved.

The conditions at this station were materially improved during the year, and as a result the work of the station was more efficiently organized and prosecuted along several lines of special importance to the agriculture of Wyoming.

STATISTICS OF LAND-GRANT COLLEGES AND AGRICULTURAL EXPERIMENT STATIONS, 1909.

By Miss M. T. SPETHMANN.

The following statistical statements relate to the institutions established under the acts of Congress of July 2, 1862, and August 30, 1890, most of which maintain courses of instruction in agriculture, and to the agricultural experiment stations, which, with few exceptions, are organized under the act of Congress of March 2, 1887, and are conducted as departments of the institutions receiving the benefits of the land-grant act of 1862. These statistics have been compiled in part from the annual reports of the presidents of these institutions made on the schedules prescribed by the Commissioner of Education. Tables showing the annual disbursements on account of the acts of Congress of March 2, 1887, August 30, 1890, March 16, 1906, and March 4, 1907, prepared from figures furnished by the Departments of the Treasury and the Interior, are also included. Owing to the complex organization of many of the institutions, it is impracticable to give exactly comparable statistics in all cases, and in some instances the data furnished are incomplete.

SUMMARY OF STATISTICS OF LAND-GRANT COLLEGES.

Educational institutions receiving the benefits of the acts of Congress of July 2, 1862, August 30, 1890, and March 4, 1907, are now in operation in all the States and Territories except Alaska. The total number of these institutions is 67, of which 65 maintain courses of instruction in agriculture. The aggregate value of the permanent funds and equipment of the land-grant colleges and universities in 1909 is estimated to be as follows: Land-grant fund of 1862, \$13,236,303.95; other land-grant funds, \$2,970,787.90; other permanent funds, \$18,078,039.86; land grant of 1862 still unsold, \$8,378,907.27; farms and grounds owned by the institutions, \$15,136,197.97; buildings, \$38,389,127.91; apparatus, \$3,553,989.54; machinery, \$2,803,629.76; libraries, \$4,136,738.96; live stock, \$542,246.03; miscellaneous equipment, \$4,656,717.81; total, \$111,882,686.96. The income of these institutions in 1909, exclusive of the funds received from the United States for agricultural experiment stations (\$1,180,780.09), was as follows: Interest on land-grant funds of 1862, \$763,274.04; interest on other land-grant funds, \$127,732.59; United States appropriation under acts of 1890 and 1907, \$1,750,000; interest on endowment or regular appropriation, \$257,295.20; state appropriations for current expenses, \$5,959,551.51; state appropriations for

buildings or for other special purposes, \$3,955,712.77; income from endowment, other than federal or state grants, \$783,719.94; tuition fees, \$1,139,916.68; incidental fees, \$1,020,052.49; miscellaneous, \$2,325,598.33; total, \$18,082,853.55. The value of the additions to the permanent endowment and equipment of these institutions in 1909 is estimated as follows: Permanent endowment, \$1,144,913.60; buildings, \$3,411,201.44; libraries, \$307,807.46; apparatus, \$303,238.64; machinery, \$163,013; live stock, \$86,454.22; miscellaneous, \$638,518.44; total, \$6,055,146.80.

The number of persons in the faculties of the colleges of agriculture and mechanic arts was as follows: For preparatory classes, 503; for collegiate and special classes, 3,294; total, counting none twice, 3,664. In the other departments the faculties aggregated 2,091, making a grand total of 5,755 persons in the faculties of the land-grant institutions.

The students in 1909 in the colleges for white persons were as follows: (1) By classes—preparatory, 6,909; collegiate, 27,579; short course or special, 13,069; postgraduate, 1,107; other departments, 21,969; total, counting none twice, 67,227. (2) By courses: Four-year—agriculture, 4,999; horticulture, 158; forestry, 223; veterinary science, 215; household economy, 1,443; engineering, 17,892. Shorter than four years—mechanic arts, 841; agriculture, 6,135; horticulture, 233; forestry, 81; dairying, 610; veterinary science, 510; household economy, 738; teachers' courses in agriculture, 197 (four-year, 144; three-year, 39; two-year, 14); summer schools of agriculture for teachers, 1,905; military tactics, 20,477.

The students in colleges and schools for colored persons were as follows: (1) By classes—preparatory, 5,109; collegiate, 951; short or special, 229; other departments, 477; total, 6,586. (2) By courses—agriculture, 1,442; industrial courses for boys, 2,331; industrial courses for girls, 4,677; military tactics, 1,678.

The graduates in 1909 were 6,353, and since the organization of these institutions, 84,749. The average age of graduates in 1909 was 22 years and 2 months. The total number of volumes in the libraries was 2,327,773, and the total number of pamphlets, 650,255. The total number of acres of land granted to the States under the act of 1862 was 10,570,842, of which 1,026,847 are still unsold.

SUMMARY OF STATISTICS OF THE STATIONS.

Agricultural experiment stations are now in operation under the acts of Congress of March 2, 1887, and March 16, 1906, in all the States and Territories, and under special appropriation acts in Alaska, Hawaii, Porto Rico, and Guam.

In Alabama, Connecticut, Hawaii, Louisiana, Missouri, New Jersey, New York, North Carolina, and Virginia separate stations are maintained wholly or in part by state funds. A number of substations

are also maintained in different States. Excluding the substations, the total number of stations in the United States is 62. Of these, 55 receive appropriations provided for by acts of Congress.

The total income of the stations maintained under the acts of 1887 and 1906 during 1909 was \$3,053,446.90, of which \$1,248,000 (Hatch fund \$720,000, Adams fund \$528,000) was received from the National Government, the remainder, \$1,805,446.90, coming from the following sources: State governments, \$1,034,803.75; individuals and communities, \$13,199.93; fees for analyses of fertilizers, \$144,326.52; sales of farm products, \$220,001.76; miscellaneous, \$393,114.94. In addition to this, the Office of Experiment Stations had an appropriation of \$314,620 for the past fiscal year, including \$26,000 each for the Alaska, Hawaii, and Porto Rico experiment stations, \$5,000 for the Guam Experiment Station, \$7,000 for nutrition investigations, \$150,000 for irrigation and drainage investigations, and \$10,000 for farmers' institutes and agricultural schools. The value of the additions to the equipment of the stations in 1909 is estimated as follows: Buildings, \$466,747.93; libraries, \$21,220.48; apparatus, \$46,691.71; farm implements, \$28,723.56; live stock, \$56,281.63; miscellaneous, \$124,896.62; total, \$744,561.93.

The stations employ 1,242 persons in the work of administration and inquiry. The number of officers engaged in the different lines of work is as follows: Directors, 57; assistant and vice-directors, 22; special agents in charge, 4; chemists, 240; agriculturists, 43; agronomists, 138; plant breeders, 12; animal husbandmen, 88; animal nutrition, 14; poultrymen, 19; horticulturists, 130; floriculturists, 5; pomologists, 5; farm and garden foremen, 31; dairymen, 71; botanists, 71; plant pathologists, 41; plant physiologists, 5; entomologists, 102; zoologists, 6; veterinarians, 40; animal pathologists, 5; meteorologists, 12; foresters, 18; mycologists, 3; biologists, 9; physicists, 11; geologists, 2; bacteriologists, 47; irrigation engineers, 12; agricultural engineers, 10; extension workers and farmers' institute directors, 17; in charge of substations, 34; secretaries and treasurers, 34; and librarians, 15. There are also 61 persons classified under the head "Miscellaneous," including superintendents of grounds and buildings, gardeners, farm mechanics, laboratory and field assistants, etc. Five hundred and two station officers do more or less teaching in the colleges with which the stations are connected. During the year the stations published 517 annual reports, bulletins, and circulars, which were supplied to over 912,000 addresses on the regular mailing lists. A larger number of stations than formerly supplemented their regular publications with more or less frequent issues of press bulletins and other special publications, and most of the stations report a large and constantly increasing correspondence with farmers on a wide variety of topics.

STATISTICS OF THE LAND-GRANT COLLEGES AND UNIVERSITIES.^a

Unless otherwise specified, the statistics reported in the tables are for the institutions as designated in the list given below.

TABLE 1.—*Institutions established under the land-grant act of July 2, 1862, and their courses of study.*

[All of the institutions in this list, except those marked with an asterisk (*), maintain courses of instruction in agriculture.]

State or Territory.	Name of institution.	Location.	President.	Collegiate courses of study (undergraduate).	
				Degree courses. ^b	Preparatory and short courses.
Alabama.....	Alabama Polytechnic Institute.	Auburn.....	C. C. Thach, M. A., L.L. D.	Agr., civil engin., archi., elect. engin., mech. engin., mining engin., phar., general, chem., and metal. (B. S.); phar. (2 yrs., Ph. G., 3 yrs., Ph. C.); vet. med. and surgery (3 yrs., D. V. M.). Sci. (B. S.), agr. (B. A. S.), mech. (B. M. S.)..	Agr., mech. arts (2 yrs.). agr. (1 yr.), summer school for farmers (10 days).
Arizona.....	Agricultural and Mechanical College for Negroes.	Normal.....	W. S. Buchanan, B. S. A.		Indus. and lit. studies (1 to 4 yrs.).
Arkansas.....	University of Arizona..	Tucson.....	K. C. Babcock, Ph. D.	Lit. (Ph. B.), sci., metal., mining engin., civil engin., mech. engin. (B. S.). Agr. (B. S. A.), mech. engin. (B. M. E.), elect. engin. (B. E. E.), civil engin. (B. C. E.), mining engin. (B. M. E.), chem. engin. (B. Ch. E.), chem. (B. S. C.), phys. (B. S. in Phys.), cement engin. (B. S. in Cem. Eng.), lit. and sci. (B. A. and B. S.), music (B. Mus.), normal (L. I.). Clas. (B. A.), normal (L. I.).....	Agr. (2 yrs.), prep. (4 yrs.). Agr. hort., dairying, elect. engin. (2 yrs.), mech. arts (2 or 3 yrs.), prep. (2 yrs.), agr. (3 weeks), art (1 yr. and 4 yrs.).
California.....	*Branch Normal College. University of California.	Pine Bluff..... Berkeley.....	Isaac Fisher..... B. I. Wheeler, Ph. D., L.L. D.	Letters (A. B.), social sci. (B. L.), natural sci., commerce, general and tech. agr. (4 yrs. each), mech. engin., elect. engin., mining engin., civil engin., chem., sugar technol. (B. S.) (4 and 5 yrs. each). Agr. mech. engin., civil and irrig. engin., elect. engin., general sci., domestic sci., hort., general sci. for women, forestry (B. S.), vet. sci. (D. V. S., 3 yrs.). Agr. (B. S.).....	Prep. (2 yrs.), manual training, mech. arts. Agr., animal indus. and vet. sci., irrig., poultry husb., dairying, nutrition, ent., vit., hort. (2-8 weeks each), summer session (6 weeks), farmers' week.
Colorado.....	The State Agricultural College of Colorado.	Fort Collins.....	C. A. Lory, M. S., L.L. D.		Agr., domestic sci. (3 yrs. of 6 months each), mech. arts (2 yrs.), bookkeeping, farriery (1 yr. each), farmers' and dom. sci. week, hbr. sci. and handicraft.
Connecticut.....	Connecticut Agricultural College.	Storrs.....	C. L. Beach, B. Agr., B. S.		Prep. (2 yrs.), dairying, poultry culture, and hort., mech. arts, home econ. (3 courses 3 yrs. each, diploma), summer school of nature study and agriculture (4 weeks), dairying, pomol. (winter, 12 weeks), poultry, forestry (6 weeks).

Delaware.....	Delaware College.....	Newark.....	G. A. Harter, M. A., Ph. D.	Class., Lat. sci. (B. A.), agr., general sci., civil engin., mech. engin., elect. engin. (B. S.), Sci. (B. S.), agr. (B. Agr.), engin. (B. E.)....	Aggr. (4 yrs.), agr. (2 yrs.), agr. (winter, 1 week).
Florida.....	State College for Colored Students. University of the State of Florida.	Dover..... Gainesville.....	W. C. Jason, A. M., D. D. A. A. Murphree, A. M., LL. D.	Lit. (B. A.), gen. sci., agr., mech. engin., elect. engin., civil engin. (B. S.), pedag. (B. A. in Ped.), law (LL. B.).	Normal (3 yrs.), industrial (2 yrs.), prep. Agr., mech. arts, pedag. (2 yrs.), prep. (1 yr.), summer school for teachers (6 weeks), corresp. course in agr. for teach- ers and farmers.
Georgia.....	Florida Agricultural and Mechanical Col- lege for Negroes. Georgia State College of Agriculture, Univer- sity of Georgia.	Tallahassee.....	N. B. Young, M. A....	Sol. (B. S.).....	Normal (2 yrs.), high school (3 yrs.), gram- mar school (3 yrs.), indus. training through all courses.
Hawaii.....	College of Hawaii.....	Athens.....	A. M. Soule, B. S. A....	General sci., agr., civil engin., elect. engin. (B. S.), phar. (2 yrs., Ph. C.).	Aggr. (4 yrs.), dairying (1 yr.), agr. (winter, 12 weeks), cotton school (10 days), farmers' week.
Idaho.....	University of Idaho.....	Savannah..... Honolulu..... Moscow.....	R. R. Wright, A. M., LL. D. J. W. Gilmore, M. S. A. J. A. MacLean, Ph. D., LL. D.	Collegiate (A. B.)..... Sci., agr., home econ. engin. (B. S.)..... Class. (B. A.) sci. (B. S.), agr. and hort., forestry (B. S. Agr.), domestic econ. (B. S. D. E.), vet. sci., civil engin. (B. S. C. E.), mining engin. (B. S. Min. E.), elect. engin. (B. S. E. E.), mech. engin. (B. S. M. E.), music (B. M.), law (3 yrs., LL. B.).	Normal (3 yrs.), industrial, prep. (3 yrs.), dairying (winter, 2 months)
Illinois.....	University of Illinois.....	Urbana.....	E. J. James, Ph. D., LL. D.	Lit. and arts, general sci. (B. A.), archi- tect. engin., civil engin., elect. engin., mech. engin., railway engin., municipal and sanitary engin., ceramics, ceramit engin., chem., chem. engin., sci., agr., domestic sci., landscape gard. (B. S.), music (B. M.), libr. sci. (B. L. S., 5 yrs.), med. (M. D.), dentistry (3 yrs., D. D. S.), phar. (2 yrs., Ph. G.), law (3 yrs., LL. B.), phar. chem. (2 yrs., Ph. C.).	Aggr. (4 yrs.), agr. (3 yrs.), dairying (coml. 1 yr.), dairying and hort. (winter, 4-6 weeks), forest rangers (winter).
Indiana.....	Purdue University.....	Lafayette.....	W. E. Stone, Ph. D., LL. D.	Mech. engin. (B. S. M. E.), civil engin., sanitary engin. (B. S. C. E.), elect. engin., mech. engin., telephone engin. (B. S. E. E.), chem. engin. (B. S.), agr. (B. S. Agr.), sci., household econ. (B. S.), phar. (B. S. Phar.), phar. (2 yrs., Ph. G.).	Summer school, including secondary and el. agr. for rural teachers (6 weeks), agr. and domestic sci. (2 weeks).
Iowa.....	Iowa State College of Agriculture and Me- chanic Arts.	Ames.....	A. B. Storms, A. M., D. D., LL. D.	Aggr., dairying, animal husb., hort. and forestry agr. engin. sci. and agr. (B. S. A.), vet. med. (D. V. M.), mech. engin. (B. M. E.), civil engin. (B. C. E.), elect. engin. (B. S. in E. E.), mining engin. (B. S. in Min. E.), sci. (B. S.), ceramics (B. E. M. in Cer.), dom. sci. (B. D. S.).	Aggr. and hort., animal husb., dairy and creamery, home econ. (winter, 8 weeks), butter making (11 days, winter), farmers' week.

^a Including also institutions receiving apportionments from the appropriation of 1890.

^b Four-year courses unless otherwise specified.

TABLE 1.—*Institutions established under the land-grant act of July 2, 1862, and their courses of study—Continued.*

State or Territory.	Name of institution.	Location.	President.	Collegiate courses of study (undergraduate).	
				Degree courses.	Preparatory and short courses.
Kansas.....	Kansas State Agricultural College.	Manhattan.....	H. J. Waters, B. S. A.	Agron., animal husb., dairy, hort., and forestry, poultry, dom. sci., mech. engin., general sci., elect. engin., civil engin., archt., printing (B. S.), vet. sci. (D. V. M.).	Prep. (1 yr.), domestic sci. (2 terms, 12 weeks each), farmers' (2 winter terms, 10 weeks each), summer domestic sci. course for teachers (10 weeks), dairying (2 winter terms, 10 weeks each), agr. for teachers (summer, 6 weeks), farmers' week.
Kentucky.....	State University.....	Lexington.....	J. K. Patterson, Ph. D., LL. D.	Clas. (A. B.), mech. engin. (B. M. E.), civil engin. (B. C. E.), mining engin. (B. E. M.), agr. (B. S. Agr.), sci., dom. sci. (B. S.), education (B. S. Edu. and A. B. Edu.), law (3 yrs., LL. B.).	Agr. (2 yrs.), prep. (3 yrs.), rural and highway engin. (2 yrs.), mining engin. (2 yrs.), pract. mining (8-10 weeks), agr. (winter, 10 weeks).
Louisiana.....	The Kentucky Normal and Industrial Institute for Colored Persons.	Frankfort.....	J. H. Jackson, A. M. ....	.....	Normal, agr., carpentry, cooking, music, dressmaking, printing, blacksmithing, wheelwrighting (3 yrs.), business (1 yr.).
	Louisiana State University and Agricultural and Mechanical College.	Baton Rouge....	T. D. Boyd, A. M., LL. D.	Agr., elect. engin., chem. engin., civil engin., mech. engin., general sci., premed. (B. S.), commerce, Lat. sci., lit., philos. and ed. (B. A.), sugar engin. (5 yrs., B. S.), law (2 yrs., LL. B.), law (3 yrs., B. C. L.).	Agr. (3 yrs.).
	Southern University and Agricultural and Mechanical College.	New Orleans....	H. A. Hill.....	.....	Sci., agr., high school, printing, girls' indus. (4 yrs.), clas., normal, manual training, grammar, mech. draw., tinmithing (3 yrs.), bookkeeping, typewriting (2 yrs.), music (5 yrs.).
Maine.....	University of Maine....	Orono.....	G. E. Fellows, Ph. D., LL. D., LL. D.	Clas. (B. A.), sci., agron., animal husb., hort., dom. sci., chem., civil engin., mech. engin., elect. engin., chem. engin., forestry, pharm., agr. for teachers (B. S.), law (3 yrs., LL. B.), pharm. (2 yrs., Ph. C.).	Secondary agr. (2 yrs.); agr. for teachers (1 yr.), agr. and dairying (4 weeks), poultry management and dom. sci. (3 weeks, spring), summer school for teachers (5 weeks), farmers' week, reading and correspondence courses in agr.
Maryland.....	Maryland Agricultural College. Princess Anne Academy for Colored Persons.	College Park.... Princess Anne....	R. W. Silvester, M. S., LL. D. Frank Trigg, A. M.	Agr., hort., chem., gen. sci., biol., mech. engin., civil engin., elect. engin. (B. S.).	Agr., hort. (2 yrs.), prep. (1 yr.), agr. (winter, 10 weeks), dairying.
Massachusetts.....	Massachusetts Agricultural College.	Amherst.....	K. L. Butterfield, A. M.	Agr. (B. S.).	Indus., acad., normal (4 yrs.), grammar (2 yrs.).
					Agr., hort., floriculture, dairying (winter, 10 weeks), summer school of agr. for teachers, et al. (2, 4, and 6 weeks).

*Massachusetts Institute of Technology.	Boston.....	R. C. Macdaurin, M. A., LL. D., D. Sc.	Civil engin., mech. engin., mining engin. and metals, archi., chem., elect. engin., biol., phys., electro-chem., chem. engin., sani- tary engin., geol. and geodesy, naval archi., general sci. (B. S.). Agr., engin., forestry, home econ. (B. S., each 4 and 5 yrs.).	Prep. (1 yr.), cheese making (4 weeks, gen- eral agr., poultry hush. (2 winter terms of 8 weeks each), creamery (2 winter terms of 6 weeks each), summer school of agr. for teachers (4 weeks), hort. (2 weeks, win- ter), forestry (2 summer terms of 6 weeks each), college ext. reading course. Agr. (3 yrs.), home econ. normal (2 yrs.), agri'l indus. course for teachers (2 yrs.), agr. (4 weeks), forestry (summer, 6 weeks), dairying, winter, 4 weeks, trac- tion engin. (4 weeks), el. agr. for teachers (summer, 3 weeks).
Michigan.....	East Lansing....	J. L. Snyder, A. M., Ph. D., LL. D.	General (B. A.), civil engin. (C. E.), mech. engin. (M. E.), elect. engin. (E. E.), min- ing, metal. (E. M. Met. E.), chem. (A. C. or C. T.), agr. (B. S. Agr.), forestry (B. S. For.), home econ. (B. S.).	El. agr., home econ. (3 yrs. each), teachers' course in agr. (1 yr.), agr. (winter, 7 weeks), teachers summer school (6 weeks).
Minnesota.....	St. Anthony Park, St. Paul.	Cyrus Northrop, LL. D.	Agr., mech. engin., elect. engin., civil and mining engin., textile indus., indus. peda- gogy (B. S.).	Class., Engl., sci. (4 yrs.), indus., agr., dom. sci. (3 yrs. each), com'l (2 yrs.), agr., dairying, bot., ent., bact., dom. sci. (6 weeks).
Mississippi.....	Agricultural College.	J. C. Hardy, A. M., LL. D.	Scientific (B. S.).	
Missouri.....	Alcorn.....	L. J. Rowan, B. S.....	Gen. Sci. (B. A.), agr., home econ. (B. S.), civil engin. (B. S., C. E.), mech. engin., min. engin. (B. S., M. E.), elect. engin. (B. S., E. E.), chem. engin., mining, metal., journalism (B. S.), law (3 yrs., LL. B.). Collegiate (B. A.).	College prep., normal (2 yrs.), normal prep., carpentry, blacksmithing, mach. work, sewing, cooking, laundering (3 yrs.), sum- mer school (7 weeks).
Montana.....	University of Missouri..	A. R. Hill, Ph. D., LL. D.	General sci., domestic sci., phar. (B. S.), agron., animal hush. and dairying, hort. and forestry (B. S. A.), mech. engin. (B. M. E.), elect. engin. (B. E. E.), civil engin. (B. C. E.), phar. (2 yrs., Ph. C.).	Prep., music, art (4 yrs.), agr. (3 yrs.), do- mestic sci. (1 yr.), creamery (4 weeks), dairying, stock judging, dom. sci. (1 week each).
Nebraska.....	Lincoln Institute.....	B. F. Allen ^d , A. M., LL. D.	Class lit. (B. A.), general sci., general and tech. agr., home econ., civil engin., elect. engin., steam engin., municipal engin., mech. engin., printed, tech. forestry, phar. (B. S.), teachers' course (B. A. and B. S.), med. (M. D.), law (3 yrs., LL. B.), phar. (3 yrs., Ph. C., 2 yrs., Ph. G.).	El. agr., home econ. (3 yrs. each), teachers' course in agr. (1 yr.), agr. (winter, 7 weeks), teachers summer school (6 weeks).
Nevada.....	University of Nebraska..	Samuel Avery, Ph. D.	Liberal arts (B. A.), mining engin., agr., do- mestic sci., mech. engin., civil engin., gen- eral sci. (B. S.).	
Nevada.....	University of Nevada...	J. E. Stubbs, M. A., D. D., LL. D.		

TABLE 1.—*Institutions established under the land-grant act of July 2, 1862, and their courses of study—Continued.*

State or Territory.	Name of institution.	Location.	President.	Collegiate courses of study (undergraduate).	
				Degree courses.	Preparatory and short courses.
New Hampshire...	The New Hampshire College of Agriculture and Mechanic Arts.	Durham.....	W. D. Gibbs, D. Sc...	Agr. mech. engin., elect. engin., chem. engin., general (B. S.).	Agr. (2 yrs.), agr. (winter, 10 weeks) dairying (winter, 10 weeks), agr. (2 weeks).
New Jersey.....	Rutgers Scientific School, The New Jersey State College for the Benefit of Agriculture and Mechanic Arts.	New Brunswick.	W. H. S. Demarest, A. M., D. D.	Clas. (A. B.), Lat. sci. (Litt. B.), general sci., agr., civil engin., mech. engin., elect. engin., chem., biol., clay working and ceramics (B. S.).	Clay working and ceramics (2 yrs.), general agr., dairy farming, fruit growing, and market gardening (winter, 12 weeks each).
New Mexico.....	New Mexico College of Agriculture and Mechanic Arts.	Agricultural College.	W. E. Garrison, Ph. D.	Agr. mech. engin., civil engin., elect. engin., household econ., commerce, general or sci. (B. S.).	Indus. agr., mech., dom. sci., business, prep. (4 yrs. each), Engl. and Engl.-Spanish sten. (2 yrs. each).
New York.....	Cornell University.....	Ithaca.....	J. G. Schurman, D. Sc., LL. D.	Arts (A. B.), civil engin. (C. E.), mech. engin. (M. E.), elect. engin. (E. E.), archi. (B. Arch.), agr. (B. S. A.), vet. med. (3 yrs., D. V. M.), law (3 yrs., LL. B.).	Arch. (2 yrs.), special lect. courses in general agr. and nature study (1 or 2 yrs.), agr. dairying, poultry husb., hort., home econ. (winter, 11 weeks), reading courses for farmers and farmers' wives, summer school for teachers, nature study correspondence course for teachers, farmers' week.
North Carolina.....	The North Carolina College of Agriculture and Mechanic Arts.	West Raleigh...	D. H. Hill, A. M., Litt. D.	Agr. (B. S.), mech. engin., civil engin., elect. engin., mining engin., textile sci. and art (B. E.), chem., dyeing (B. S.).	Mech. arts, textile art (2 yrs.), normal courses in agr. and nature study (1 and 2 yrs.), agr. (1 yr.), agr. and dairying (7 weeks, winter), May school for agr. teachers (1 month), cotton culture (1 week, winter).
North Dakota.....	The Agricultural and Mechanical College for the Colored Race, North Dakota Agricultural College.	Greensboro.....	J. B. Dudley, A. M., LL. D.....	Agr. (B. Agr.), mech. (B. S.).....	Prep. (4 yrs.), agr. (2 yrs.).
		Agricultural College.	J. H. West, LL. D....	Agr., gen. sci., dom. sci., biol., mech. engin., civil engin., pharm., chem., education, vet. sci. (B. S.).	Farm husb., power mach. (3 yrs. each), pharm., dom. econ. (2 and 3 yrs. each), high-school agr., commerce, dom. sci., engin. and manual training, general sci. (3 yrs.), nature study, el. agr. and manual training for rural teachers (3 yrs.), agr., steam engin., dom. econ. (winter, 12 weeks each).

Ohio.....	Ohio State University..	Columbus.....	W. O. Thompson, A. M., D. D., LL. D.	Agri. (B. S. Agr.), ed., hort., forestry, dom. sci., chem., engin., indus. arts, manual training, phar. (B. S.), arts, philos. and sci. (B. A.), archi. (C. E. in Archi.), civil engin. (C. E.), ceramic engin. (Cer. E.), min. engin. (E. M.), elect. engin. (M. E. in E. E.), mech. engin. (M. E.), vet. med. (3 yrs., D. V. M.), law (3 yrs., LL. B.). Agr., mech. engin., archi. and civil engin., elect. engin., sci. and lit., dom. sci. and art, normal (B. S.).	Agri., hort., ed., indus. arts, mining, phar. (2 yrs.), clay working and ceramics, agr. (10 weeks), summer session (8 weeks), winter dairy school, winter school for home-makers (1 month).
Oklahoma.....	Oklahoma Agricultural and Mechanical College.	Stillwater.....	J. H. Connell, M. S....	Clas. (B. A.), sci. (B. S.), normal (B. S. D.), agr. (B. S. Agr.), elect. engin., mech. engin., civil archi. (B. M. E.). Agron., hort., animal husb., dairy husb., poultry husb., mech. engin., elect. engin., civil engin., mining engin., dom. sci. and art, forestry, phar., commerce (B. S.).	Agri. and dom. sci. (2 yrs.), business, agr. (1 yr.), agr. and dairy (winter, 10 weeks), dairying (4 weeks), cotton grading (3 weeks), summer normal for teachers of agr. (6 weeks), reading course in agr. for teachers (2 yrs.), farmers' week. Normal el. (4 yrs.), college prep. (3 yrs.).
Oregon.....	Agricultural and Normal University.	Langston.....	I. E. Page, M. A.....	Clas. (B. A.), sci. (B. S.), normal (B. S. D.), agr. (B. S. Agr.), elect. engin., mech. engin., civil archi. (B. M. E.). Agron., hort., animal husb., dairy husb., poultry husb., mech. engin., elect. engin., civil engin., mining engin., dom. sci. and art, forestry, phar., commerce (B. S.).	Sec. agr., dom. sci. and art, commerce, forestry, mech. arts (2 yrs.), phar. (2 yrs.), general agr., dairying, hort., forest rangers (winter, 6 weeks each), summer school for teachers (6 weeks), farmers' week, music, art.
Pennsylvania.....	The Pennsylvania State College.	State College....	E. E. Sparks, Ph. D., LL. D.	Clas. (B. A.), mod. lang. and lit., general sci., and ed., agr. (B. S. Agr.), animal husb., dairying, hort., forestry, home econ., biol., chem., civil engin., elect. engin., electrochem. engin., indus. chem., indus. engin., math., mech. engin., mines and metal, plant path., phys., sanitary engin. (B. S.).	Agri., mech. arts for teachers (2 yrs.), agr., hort., dairy husb. and mant., poultry husb., (12 weeks), summer session for teachers (6 weeks), 32 corresp. courses in agr., farmers' week.
Porto Rico.....	University of Porto Rico.	San Juan.....	E. G. Dexter, A. M., Ph. D.	Agri., mech. engin., civil engin., chem. engin., elect. engin., teachers' course in applied sci. and home econ. (B. S.). Agr., agr. and chem., agr. and animal husb., mech. and elect. engin., civil engin., chem. and geol., textile indus. (B. S.). Regular (B. A.), mech. (B. S.), agr. (B. Agr.).	Normal nature study, el. agr., sewing, bot., zool. (18 weeks each), dom. sci., school gardening (1 yr. each). Agr. (2 yrs.), engin. (2 yrs.), dom. sci. (2 yrs.), poultry school (winter, 6 weeks).
Rhode Island.....	Rhode Island State College.	Kingston.....	Howard Edwards, M. A., LL. D.	Agri., mech. engin., civil engin., chem. engin., elect. engin., teachers' course in applied sci. and home econ. (B. S.). Agr., agr. and chem., agr. and animal husb., mech. and elect. engin., civil engin., chem. and geol., textile indus. (B. S.). Regular (B. A.), mech. (B. S.), agr. (B. Agr.).	Normal nature study, el. agr., sewing, bot., zool. (18 weeks each), dom. sci., school gardening (1 yr. each). Agr. (2 yrs.), engin. (2 yrs.), dom. sci. (2 yrs.), poultry school (winter, 6 weeks).
South Carolina.....	The Clemson Agricultural College of South Carolina.	Clemson College.	A. W. M. Riggs, E. M. E.	Agri., mech. engin., civil engin., chem. engin., elect. engin., teachers' course in applied sci. and home econ. (B. S.). Agr., agr. and chem., agr. and animal husb., mech. and elect. engin., civil engin., chem. and geol., textile indus. (B. S.). Regular (B. A.), mech. (B. S.), agr. (B. Agr.).	Normal nature study, el. agr., sewing, bot., zool. (18 weeks each), dom. sci., school gardening (1 yr. each). Agr. (2 yrs.), engin. (2 yrs.), dom. sci. (2 yrs.), poultry school (winter, 6 weeks).
South Dakota.....	The Colored Normal, Industrial, Agricultural and Mechanical College of South Carolina.	Orangeburg.....	T. E. Miller, LL. D....	Agri., mech. engin., civil engin., chem. engin., elect. engin., teachers' course in applied sci. and home econ. (B. S.). Agr., agr. and chem., agr. and animal husb., mech. and elect. engin., civil engin., chem. and geol., textile indus. (B. S.). Regular (B. A.), mech. (B. S.), agr. (B. Agr.).	Normal nature study, el. agr., sewing, bot., zool. (18 weeks each), dom. sci., school gardening (1 yr. each). Agr. (2 yrs.), engin. (2 yrs.), dom. sci. (2 yrs.), poultry school (winter, 6 weeks).
South Dakota.....	The Dakota State College of Agriculture and Mechanic Arts.	Brookings.....	R. L. Slagle, A. M., Ph. D.	Agri., domestic sci., general sci., mech. engin., elect. engin., civil engin., phar. (B. S.), phar. (2 yrs., Ph. G.).	Prep. and normal (5 yrs.), model school, indus., music, art.

a Acting president.

TABLE 1.—*Institutions established under the land-grant act of July 2, 1862, and their courses of study—Continued.*

State or Territory.	Name of institution.	Location.	President.	Degree courses.	Collegiate courses of study (undergraduate).	Preparatory and short courses.
Tennessee.....	University of Tennessee.	Knoxville.....	Brown Ayres, Ph. D., LL. D., D. C. L.	Lit. (B. A.), agr., home econ., sci., civil engin., mech. engin., elect. engin., mining engin., metal. chem. engin., phar. chem. (B. S.), med. (M. D.), education (B. A. and B. S. in Ed.), dental surgery (3 yrs., D. D. S.), phar. chem. (2 yrs., Ph. C.), law (2 yrs., LL. B.).	El. agr. for negroes (4 yrs.), agr., prep. med. (2 yrs. each), agron., hort., animal husb., dairy husb., poultry husb., bee keeping, home econ. (8 weeks each), summer school for teachers (6 weeks).	
Texas.....	Agricultural and Mechanical College of Texas.	College Station..	R. T. Milner.....	Agr., textile engin., elect. engin., mech. engin., civil engin., archit. engin., chem. engin. (B. S.)	Agr. (2 yrs.), textile engin. (2 yrs), summer school (6 weeks), summer normal (6 weeks).	
Utah.....	Prairie View State Normal and Industrial College.	Prairie View....	E. L. Blackshear.....		Normal and indus. (4 yrs.), agr. and hort. (2 yrs.), dairying (2 yrs.).	
Utah.....	Agricultural College of Utah.	Logan.....	J. A. Widtsoe, Ph. D.	Agron., hort. and ent., animal husb. and dairying, irrig. and drainage, forestry, domestic sci., commerce, general sci. (B. S.).	Manual training in mech. arts (4 yrs.), manual training in agr. and domestic sci. (3 yrs. each), commerce (3 yrs.), prep. (3 yrs.) sci. (2 yrs.), agr. domestic sci. and arts (8 weeks), mech. arts (10 weeks), forestry (12 weeks), commerce (8 weeks), summer school (5 weeks), farmers' roundup (8 weeks) music.	
Vermont.....	University of Vermont and State Agricultural College.	Burlington.....	M. H. Buckingham, D. D., LL. D.	Clas. (B. A.), lit. sci. (Ph. B.), civil and sanitary engin., elect. engin., mech. engin., chem., agr., commerce and econ. (B. S.), med. (M. D.).	Agr. (2 yrs.) agr. and dairying (winter, 8 weeks), summer school for teachers (4 weeks), farmers' week.	
Virginia.....	The Virginia Agricultural and Mechanical College and Polytechnic Institute.	Blacksburg.....	P. B. Barringer, M. D., LL. D.	Agr., hort., applied chem., civil engin., mech. engin., elect. engin., mining engin., metal. and metallography, applied geol., prep. vet. med. (B. S.).	Agr. apprentice course (1 yr.), farmers' winter course (1 month).	
Washington.....	State College of Washington.	Pullman.....	E. A. Bryan, A. M., LL. D.	Math. and civil engin., math. and phys., hydro-elect. engin., domestic econ., phar. chem., bot., zool., agron., animal husb. and dairying, hort., vet. sci., econ. sci. and hist., elect. engin., mech. engin., mining engin. (B. S., B. A.), geol., Engl. lang. and lit., modern lang., Latin, education, archi. (B. A.), vet. sci. (3 yrs., D. V. S.), phar. (2 yrs., Ph. G.), music (3 yrs., B. Mus.).	Academic (4 yrs.), trade (3 yrs.) pract. agr. (3 yrs.). Graduate: Agr. (3 yrs.), dom. sci. and art (2 yrs.), matrons' course (1 or 2 yrs.) normal (2 yrs.), business (1 yr.), library methods.	

West Virginia.....	West Virginia University.	Morgantown.....	D. B. Purinton, Ph. D., LL. D.	General culture (B. A., B. S.), mech. and elect. engin. (B. S. M. E. and B. S. E. E.), civil engin. (B. S. C. E.), mining engin. (B. S. E. M.), agr. (B. S. Agr.), law (LL. B.), vet. sci. (3 yrs., D. V. S.).	Sec. agr. (3 yrs., diploma), law, commercial (2 yrs.), agr. prep. (1 yr.), agr. hort., animal husb., dairying, poultry culture (12 weeks), el. agr. and nature study for teachers (summer, 6 weeks), agr. (winter, 4 weeks), music.
	The West Virginia Colored Institute.	Institute.....	Byrd Prillerman, A. M.	.....	Normal, agr., acad., mech., printing (4 yrs.), sewing, dressmaking, com'l, cooking, millinery.
Wisconsin.....	University of Wisconsin.	Madison.....	C. R. Van Hise, Ph. D., LL. D.	Sci., commerce, journalism (B. A.), normal (B. Ph.), agr. (B. S. Agr.), civil engin., mining engin., mech. engin., elect. engin., general engin., applied electrochem., chem., phar., home econ. (B. S.), law (3 yrs. prof., LL. B.), phar. (2 yrs., Ph. G.).	Aggr. (2 yrs.), agr. (2 winter courses, 14 weeks each), dairy school (winter, 12 weeks), creamery (summer, 10 weeks), farmers' course (2 weeks), summer school (6 weeks), spec. cheese and creamery (1 week), housekeepers' conf. corresp., music.
Wyoming.....	University of Wyoming.	Laramie.....	C. O. Merica, A. M., LL. D.	Clas., lit., sci., education (B. A.), polit. sci., hist., general sci., agr., home econ., mech. engin., mining engin., irrig. engin. (B. S.), commerce (B. S. in Conn.), normal (2 yrs., B. Ped.).	Prep., commerce (4 yrs.), agr. (1 to 2 yrs.), agr. (12 weeks), school of mines (6 weeks), animal husb. (winter), domestic sci., irrig., live-stock management and judging (2 weeks), summer school for teachers (6 weeks), music, corresp. courses.

TABLE 2.—General statistics

	State or Territory.	Date of establishment of institution.	Date of establishment of agricultural course.	Faculty.				Experiment station officers.
				College of agriculture and mechanic arts.			Other departments.	
				Preparatory classes. (a)	Collegiate and special courses.	Total.		
1	Alabama (Auburn).....	1872	1872	4	54	58		19
2	Alabama (Normal).....	1875	1882	9		9	9	
3	Arizona.....	1891	1891	20	21	b 32		12
4	Arkansas (Fayetteville).....	1872	1872	17	60	77	56	20
5	Arkansas (Pine Bluff).....	1875			2	2	8	
6	California.....	1868	1868	2	87	89	285	54
7	Colorado.....	1877	1878		66	66	10	20
8	Connecticut.....	1881	1881	11	24	c 24		12
9	Delaware (Newark).....	1870	1870		22	22	1	10
10	Delaware (Dover).....	1892	1892	6	6	c 8		
11	Florida (Gainesville).....	1884	1884	1	16	17		15
12	Florida (Tallahassee).....	1887	1890	16	6	22		
13	Georgia (Athens).....	1872	1872		40	40		
14	Georgia (Savannah).....	1890	1890	12	4	16		
15	Hawaii.....	1907	1907	4	12	c 12		
16	Idaho.....	1892	1892	5	28	33	12	10
17	Illinois.....	1867	1868	13	313	326	184	58
18	Indiana.....	1874	1874		146	146		41
19	Iowa.....	1869	1869		146	146	17	31
20	Kansas.....	1863	1874	7	96	103	21	41
21	Kentucky (Lexington).....	1865	1880	5	52	57	3	26
22	Kentucky (Frankfort).....	1887	1892	5	8	13		
23	Louisiana (Baton Rouge).....	1877	1887	18	44	45	5	26
24	Louisiana (New Orleans).....	1880	1890	10	8	18		
25	Maine.....	1865	1868	9	63	c 63	11	22
26	Maryland (College Park).....	1859	1859	3	21	c 22		18
27	Maryland (Princess Anne).....			13		13		
28	Massachusetts (Amherst).....	1867	1867		40	40	7	27
29	Massachusetts (Boston).....	1865			214	214	31	
30	Michigan.....	1855	1855		97	97		25
31	Minnesota.....	1869	1869	50	27	77	162	26
32	Mississippi (Agricultural College).....	1880	1880	7	42	49		19
33	Mississippi (Abernethy).....	1871	1878	6	7	13	9	
34	Missouri (Columbia).....	1870	1870		30	30	132	38
35	Missouri (Jefferson City).....	1866	1866	7	7	c 7	16	
36	Montana.....	1893	1893	17	30	c 32	4	19
37	Nebraska.....	1869	1869	42	17	59	113	13
38	Nevada.....	1873	1888	11	28	39		14
39	New Hampshire.....	1866	1866		32	32		12
40	New Jersey.....	1864	1865	13	36	c 48	4	10
41	New Mexico.....	1889	1890	3	31	34		14
42	New York.....	1865	1865		147	147	431	37
43	North Carolina (West Raleigh).....	1889	1889		42	42		17
44	North Carolina (Greensboro).....	1891	1891	1	13	14	3	
45	North Dakota.....	1890	1890	43	44	c 47	8	28
46	Ohio.....	1870	1873		141	141	67	
47	Oklahoma (Stillwater).....	1891	1892	4	34	38		15
48	Oklahoma (Langston).....	1897	1899	2	8	10	9	
49	Oregon.....	1868	1888		69	69	4	34
50	Pennsylvania.....	1855	1859	14	123	137		38
51	Porto Rico.....	1903	1904	2		2	17	
52	Rhode Island.....	1888	1890		25	25		17
53	South Carolina (Clemson College).....	1889	1893	1	44	45		12
54	South Carolina (Orangeburg).....	1896	1896	8	6	14	12	
55	South Dakota.....	1881	1884	6	43	c 48		23
56	Tennessee.....	1794	1869	12	61	c 61	47	22
57	Texas (College Station).....	1871	1871		46	46		19
58	Texas (Prairie View).....			8	7	15	12	
59	Utah.....	1888	1889	29	26	55		18
60	Vermont.....	1865	1885		48	48	38	16
61	Virginia (Blacksburg).....	1872	1872	2	63	c 64		17
62	Virginia (Hampton).....	1868	1890	9	87	96		
63	Washington.....	1892	1892	10	61	71		24
64	West Virginia (Morgantown).....	1867	1867		37	37	29	15
65	West Virginia (Institute).....	1891	1892	6	16	22		
66	Wisconsin.....	1848	1866		103	103	294	64
67	Wyoming.....	1887	1891		17	17	20	12
Total.....				503	3,294	3,664	2,091	1,080

^a Including schools of agriculture of high-school grade under the control of the institution.^b Including all departments of the university.

of land-grant colleges, 1909.

Graduates.		Library.		Number of acres allotted to State under act of 1862.	Number of acres of land grant of 1862 still unsold.	Number of acres in farm and grounds.	Rate of interest on land-grant fund of 1862.	
In 1908-9.		Total number since organization.	Number of volumes.	Number of pamphlets.				
Num-ber.	Average age.							
	Y. M.						Per cent.	
104	24	1,157	23,000	3,000	240,000	325	8	1
38	19	1,354	800	1,500	-----	182	-----	2
7	25	67	12,000	13,000	-----	465	-----	3
71	25	656	14,165	5,000	150,000	160	8	4
15	19	212	3,400	1,500	-----	20	-----	5
343	23	b 5,661	231,000	60,000	150,000	1,402	1,599	6
31	-----	362	40,000	38,000	90,000	40,000	1,818	6
29	21 3	313	11,110	1,000	180,000	-----	662	7
19	23	446	17,000	9,100	90,000	-----	227	8
7	20	71	800	600	-----	97	-----	9
8	19 11	126	4,000	10,000	90,000	-----	520	10
14	22	130	2,074	-----	-----	200	-----	11
33	22 6	493	35,000	-----	270,000	-----	830	12
-----	-----	188	700	400	-----	-----	86	13
-----	-----	-----	4,370	7,600	-----	-----	41	14
40	-----	255	17,300	-----	90,000	81,560	225	15
409	23 6	b 5,717	134,298	18,180	480,000	40	715	16
306	23 10	3,326	22,300	4,700	390,000	-----	241	17
226	-----	-----	27,000	10,000	204,000	-----	1,175	18
125	23 6	1,567	33,842	800	82,313	-----	430	19
64	22	751	7,505	17,068	330,000	-----	298	20
25	22	213	1,420	1,750	-----	-----	310	21
47	22 4	541	28,000	-----	210,000	-----	664	22
35	18 11	453	2,633	5,140	-----	-----	104	23
92	23 6	1,326	39,205	10,000	210,000	-----	473	24
18	21	-----	7,300	1,000	210,000	-----	250	25
18	18	104	1,800	600	-----	-----	118	26
51	-----	822	33,000	-----	360,000	-----	401	27
232	23 1	4,094	81,802	22,594	-----	-----	18	28
98	23 6	1,453	30,528	6,358	235,673	50,722	684	29
317	-----	b 7,366	135,000	-----	94,000	40	1,351	30
61	20 7	581	13,540	13,419	207,920	-----	2,000	31
19	22	323	2,700	-----	-----	-----	600	32
333	22 7	3,390	100,934	-----	277,016	47,607	700	33
72	21	516	3,000	2,000	-----	-----	48	34
17	23	95	9,800	6,000	90,000	d 122,919	380	35
261	22	b 3,447	83,000	9,500	90,000	7,883	332	36
39	23	403	16,140	16,360	90,000	2,200	95	37
33	22	379	24,781	8,000	150,000	-----	345	38
32	22 7	702	59,188	5,000	210,000	-----	142	39
7	25	97	12,023	5,000	-----	-----	489	40
679	-----	b 10,697	353,638	53,000	989,920	-----	1,042	41
64	21 10	468	6,324	2,000	270,000	-----	685	42
17	21	102	1,428	17,000	-----	-----	128	43
20	24 10	88	21,137	900	130,000	45,000	640	44
333	23	3,005	84,656	4,000	630,000	-----	439	45
31	21 5	215	13,100	30,000	250,000	250,000	1,000	46
1	21	846	975	300	-----	-----	160	47
109	22 6	-----	7,258	10,000	90,000	4,200	224	48
145	23	1,309	37,000	-----	780,000	-----	400	49
-----	-----	-----	2,900	1,300	-----	-----	270	50
13	22	150	16,971	3,000	120,000	-----	178	51
55	18 6	605	29,419	8,000	180,000	-----	1,136	52
43	20	506	1,200	1,000	-----	-----	130	53
38	22	399	11,500	10,914	160,000	155,682	500	54
108	24	-----	28,550	19,000	300,000	-----	272	55
52	-----	729	21,000	-----	180,000	-----	2,416	56
79	20	669	2,200	-----	-----	-----	1,490	57
20	23 11	174	16,895	16,723	200,000	47,218	121	58
72	24 7	4,070	78,159	33,728	150,000	-----	146	59
46	21 3	817	10,300	30,000	300,000	-----	408	60
65	-----	1,572	25,000	10,000	-----	-----	760	61
92	24	424	16,897	11,000	90,000	80,062	466	62
57	23	1,222	39,343	14,371	150,000	-----	130	63
41	21	229	3,225	1,850	-----	-----	70	64
467	22	b 7,126	144,980	46,000	240,000	312	622	65
10	-----	170	26,000	12,000	90,000	90,000	514	66
6,353	22 2	84,749	2,327,773	650,255	10,570,842	1,026,847	34,227	67

c Total, counting none twice.

d Including all land grants.

TABLE 3.—Students, by classes and

PART 1.—WHITE STUDENTS.

State or Territory.	By classes.						By courses.	
	Prepara- tory. ^a	Col- legiate.	Short or spe- cial. ^b	Post grad- uate.	Other depart- ments.	Total.	Four-year.	
							Agric- ulture.	Hort- iculture.
1 Alabama.....	96	580	.....	25	.....	701	37	.....
2 Arizona.....	100	82	.....	10	.....	201	6	.....
3 Arkansas.....	428	740	9	6	470	1,689	<i>d</i> 75	31
4 California.....	18	1,007	100	43	2,385	3,553	155	(<i>e</i>)
5 Colorado.....	.....	259	111	5	138	513	38	25
6 Connecticut.....	70	97	123	.....	.....	<i>f</i> 288	53	15
7 Delaware.....	.....	175	9	.....	.....	184	2	.....
8 Florida.....	28	68	<i>g</i> 438	7	.....	541	4	.....
9 Georgia.....	.....	301	85	2	.....	388	29	.....
10 Hawaii.....	5	36	61	.....	.....	102	1	.....
11 Idaho.....	206	158	51	.....	134	<i>f</i> 543	28	.....
12 Illinois.....	354	1,776	664	89	2,428	<i>f</i> 4,972	<i>h</i> 483	.....
13 Indiana.....	.....	1,719	132	85	.....	1,936	156	(<i>e</i>)
14 Iowa.....	271	1,752	865	14	.....	<i>f</i> 2,631	515	(<i>e</i>)
15 Kansas.....	655	1,286	425	28	.....	<i>f</i> 2,308	264	.....
16 Kentucky.....	188	419	216	11	.....	834	15	.....
17 Louisiana.....	147	390	.....	8	112	657	22	.....
18 Maine.....	21	620	148	16	115	<i>f</i> 884	40	.....
19 Maryland.....	31	164	19	12	.....	220	16	9
20 Massachusetts.....	.....	267	232	12	.....	508	266	.....
21 Massachusetts (Boston).....	.....	1,436	.....	26	.....	1,462	.....	.....
22 Michigan.....	214	918	233	5	.....	1,370	329	.....
23 Minnesota.....	641	650	384	8	2,883	4,566	77	.....
24 Mississippi.....	258	553	396	6	.....	1,213	<i>i</i> 258	.....
25 Missouri.....	.....	274	148	24	<i>k</i> 2,409	2,855	239	.....
26 Montana.....	170	168	35	6	57	436	25	.....
27 Nebraska.....	341	687	206	156	2,319	<i>f</i> 3,611	40	.....
28 Nevada.....	95	201	.....	3	26	325	1	.....
29 New Hampshire.....	25	197	8	1	.....	231	39	.....
30 New Jersey.....	145	232	60	3	70	510	12	.....
31 New Mexico.....	197	58	31	5	.....	291	15	.....
32 New York.....	.....	1,577	1,253	310	2,138	<i>f</i> 4,859	415	.....
33 North Carolina.....	.....	309	126	11	.....	446	60	.....
34 North Dakota.....	460	150	677	6	.....	1,293	41	.....
35 Ohio.....	.....	1,200	874	14	1,207	<i>f</i> 3,050	134	28
36 Oklahoma.....	162	333	919	.....	.....	1,414	55	.....
37 Oregon.....	164	913	225	22	62	<i>f</i> 1,351	141	.....
38 Pennsylvania.....	46	1,071	<i>m</i> 1,606	2	.....	1,209	57	.....
39 Porto Rico.....	155	.....	.....	.....	320	475	.....	.....
40 Rhode Island.....	48	120	19	3	.....	<i>f</i> 184	<i>n</i> 38	.....
41 South Carolina.....	89	548	.....	11	.....	648	238	(<i>e</i>)
42 South Dakota.....	217	164	336	11	.....	728	23	.....
43 Tennessee.....	123	430	296	9	235	973	29	.....
44 Texas.....	.....	599	46	5	.....	650	98	.....
45 Utah.....	262	184	130	2	254	832	87	.....
46 Vermont.....	.....	360	31	2	175	568	43	.....
47 Virginia.....	83	460	59	22	.....	<i>f</i> 1,624	51	11
48 Washington.....	367	618	369	20	.....	<i>f</i> 1,282	39	39
49 West Virginia.....	29	134	52	.....	1,123	1,338	9	.....
50 Wisconsin.....	.....	1,100	847	46	2,690	<i>f</i> 4,521	195	7
51 Wyoming.....	.....	39	.....	1	219	259	7	.....
Total.....	6,909	27,579	13,069	1,107	21,969	67,227	4,999	158

^a Including schools of agriculture of high-school grade under the control of the institution.^b Including summer schools.^c Three-year and less.^d Including 12 students in four-year teachers' course.^e Included under agriculture.^f Total, counting none twice.^g Correspondence course for teachers.

courses, at land-grant colleges, in 1909.

PART 1.—WHITE STUDENTS.

By courses—Continued.													
Four-year.				Shorter.									
For- estry.	Vet- eri- ary sci- ence.	House- hold econ- omy.	Engi- neer- ing.	Mechan- ic arts.	Agric- ulture. ^a	Horti- culture.	For- estry.	Dairy- ing.	Vet- eri- ary sci- ence. ^c	House- hold econ- omy.	Teachers' courses in agriculture.		Military tac- tics.
											One to three years.	Sum- mer school.	
			310						42				628
			16		9								68
	14		245	35	34	(^e)		(^e)	13		14		635
(^e)			909		22	37		34	30				956
		22	106	2	70		10		47	29			203
		8	21		14	1		13		1			127
			144		9							94	182
			37	54									89
			49		85							9438	326
			4	3	2							355	
			12	87	45					26			216
		104	1,309					6		71			1,336
9		31	1,753		65	(^e)		19	49	90		15	750
25	126	125	795		681	(^e)	(^e)	77		2			243
27	61	360	424		197	(^e)		18		169			872
		3	267		46								259
			189										285
41			387		70								188
			99		22	1							200
					66							166	212
			907										304
(^e)		184	410		150	13	1	49				20	607
71		44	623		810		18	107				90	1,022
			220	6		2		2				372	816
		35	712		148								407
		38	63	72	32			31		53			213
37		25	410	8	599					5			483
			84							40			120
			128		25			8					155
			63		60								225
		4	14	4						2			156
			1,864		364				94				550
			233	33	54							14	400
		8	38	251	212					31	39		192
(ⁱ)		107	804	11	68	7		31	187	4			1,058
			134		646			6					448
13		153	411	77	98	53	13	16		54		192	828
		18	751		130							43	704
					115					40			
(^e)	(^e)	9	72	11	28								114
			321										630
		15	113	80	139			14		30			202
		30	154		63							106	161
			506		46								650
		39		87	134	49	17		10	89			199
			117					31					139
	9		344		142								518
	5	69	218	19	56	70	22		38				445
			107		81								150
			870		496			148					731
			27	1	2					2			75
223	215	1,443	17,892	841	6,135	233	81	610	510	738	53	1,905	20,477

^a Including 18 students in four-year teachers' course.

^c Including 13 students in rural and highway engineering.

ⁱ Including 102 students in four-year teachers' course.

^k Including students in agriculture and horticulture in the School of Education.

^l Included under horticulture.

^m Including correspondence courses.

ⁿ Including 12 students in four-year teachers' course.

TABLE 3.—*Students, by classes and*

PART 2.—NEGRO STUDENTS.

State or Territory.	By classes.					By courses.		
	Preparatory.	Collegiate.	Short or special.	Other depart- ments.	Total.	Agriculture.	Carpentry.	Machine-shop work.
1 Alabama (Normal).....	180	.....	.....	180	^a 180	21	10	11
2 Arkansas (Pine Bluff).....	174	40	.....	.....	214	.....	54	22
3 Delaware (Dover).....	60	54	22	.....	136	25	20	9
4 Florida (Tallahassee).....	261	10	.....	18	289	59	17	.....
5 Georgia (Savannah).....	373	.....	.....	.....	373	2	28	1
6 Kentucky (Frankfort).....	131	157	39	.....	327	11	40	.....
7 Louisiana (New Orleans).....	431	5	.....	.....	436	52	63	.....
8 Maryland (Princess Anne).....	146	.....	.....	.....	146	73	15	.....
9 Mississippi (Alcorn).....	388	99	.....	.....	487	83	77	.....
10 Missouri (Jefferson City).....	291	2	60	221	574	34	60	35
11 North Carolina (Greensboro).....	73	100	103	.....	276	100	20	15
12 Oklahoma (Langston).....	269	64	.....	35	368	334	34	25
13 South Carolina (Orangeburg).....	588	58	5	.....	651	15	27	47
14 Texas (Prairie View).....	306	206	.....	.....	512	116	62	5
15 Virginia (Hampton).....	1,359	.....	.....	^b 23	1,382	464	64	16
16 West Virginia (Institute).....	79	156	.....	.....	235	53	13	.....
Total.....	5,109	951	229	477	6,586	1,442	604	186

^a Total, counting none twice.^b Post graduate.

courses, at land-grant colleges, in 1909—Continued.

PART 2.—NEGRO STUDENTS.

By courses—Continued.

Blacksmithing.	Shoemaking.	Wheelwrighting.	Bricklaying.	Painting.	Printing.	Harnessmaking.	Tailoring.	Plastering.	Sewing.	Cooking.	Laundrying.	Nursing.	Millinery.	Military tactics.
10	12	13	15	.....	18	.....	15	.....	35	8	4	6	2	115
32					2				106					150
3		5		7	10		21		30	16	14			60
9							47	50	94	102	102	51	13	112
27	24	12	50	16	68				81					206
				25	19				82	22				123
				2	7				278		25		10	7
6		4							84	62	12			62
60	37	10	6	25		37			110	60	110			9
									163	163	163			10
17			25						12	20				11
37									151	159		4		12
47		47	83	10		24	90	83	300	68				13
41	12	4					6		300	300	298		54	14
46	13	23	c 73	34	7	30	31		250	260	322			15
14		5	11	4	9			11	93	50	16		12	16
349	98	123	263	123	140	91	210	144	2,169	1,290	1,066	61	91	1,678

c Including plastering.

TABLE 4.—*Value of permanent funds and*

	State or Territory.	Land-grant fund of 1862.	Other land-grant funds.	Other permanent funds.	Land grant of 1862 still unsold.	Farms and grounds owned by the institution.
1	Alabama (Auburn).....	\$253,500.00				\$9,000.00
2	Alabama (Normal).....					56,014.56
3	Arizona.....			\$10,500.00		29,140.00
4	Arkansas (Fayetteville).....	130,000.00				15,000.00
5	Arkansas (Pine Bluff).....					60,000.00
6	California.....	732,233.14	\$154,712.27	3,425,009.93	\$11,818.27	^a 1,592,504.00
7	Colorado.....	138,315.48			125,000.00	225,000.00
8	Connecticut.....	135,000.00		61,000.00		35,500.00
9	Delaware (Newark).....	83,000.00				45,000.00
10	Delaware (Dover).....					6,000.00
11	Florida (Gainesville).....	153,800.00	38,000.00			51,000.00
12	Florida (Tallahassee).....					10,000.00
13	Georgia (Athens).....	242,202.17				445,000.00
14	Georgia (Savannah).....					6,776.25
15	Hawaii.....					60,000.00
16	Idaho.....	31,950.58	324,334.57		815,600.00	55,000.00
17	Illinois.....	645,171.53			400.00	410,000.00
18	Indiana.....	340,000.00				110,000.00
19	Iowa.....	686,777.97				146,872.50
20	Kansas.....	505,048.56				228,545.00
21	Kentucky (Lexington).....	144,075.00				465,392.00
22	Kentucky (Frankfort).....	20,925.00				25,100.00
23	Louisiana (Baton Rouge).....	182,313.03	136,000.00			151,040.00
24	Louisiana (New Orleans).....					50,000.00
25	Maine.....	118,300.00		100,000.00		50,000.00
26	Maryland (College Park).....	118,000.00				30,000.00
27	Maryland (Princess Anne).....					4,000.00
28	Massachusetts (Amherst).....	219,000.00		142,000.00		44,350.00
29	Massachusetts (Boston).....	(^c)		1,871,564.00		2,724,200.00
30	Michigan.....	981,576.49			76,000.00	54,107.50
31	Minnesota.....	570,747.59	843,069.76		240.00	1,515,782.00
32	Mississippi (Agricultural College).....	98,575.00	141,212.55	250.00		60,040.00
33	Mississippi (Alcorn).....	113,575.00	96,296.00			9,000.00
34	Missouri (Columbia).....	349,881.19	220,000.00	684,958.23	60,000.00	523,550.00
35	Missouri (Jefferson City).....					20,000.00
36	Montana.....	257,162.21			^d 1,229,190.00	63,000.00
37	Nebraska.....	497,940.00	189,022.00		118,252.00	327,800.00
38	Nevada.....	101,710.00	43,415.34		15,000.00	73,723.81
39	New Hampshire.....	80,000.00		70,000.00		30,000.00
40	New Jersey.....	116,000.00		679,526.20		155,000.00
41	New Mexico.....		21,656.76			37,475.00
42	New York.....	688,576.12		8,168,182.67		242,855.35
43	North Carolina (West Raleigh).....	125,000.00				60,000.00
44	North Carolina (Greensboro).....					27,000.00
45	North Dakota.....	861,543.42			500,000.00	38,000.00
46	Ohio.....	524,176.58	110,261.76	273,523.30		1,540,000.00
47	Oklahoma (Stillwater).....				1,250,000.00	50,000.00
48	Oklahoma (Langston).....					8,000.00
49	Oregon.....	196,519.00			5,000.00	336,000.00
50	Pennsylvania.....	427,290.50		89,709.50		56,000.00
51	Porto Rico.....					32,000.00
52	Rhode Island.....	50,000.00				14,855.00
53	South Carolina (Clemson College).....	95,900.00		58,539.00		53,800.00
54	South Carolina (Orangeburg).....	95,900.00				40,000.00
55	South Dakota.....	70,086.82			1,600,000.00	65,000.00
56	Tennessee.....	400,000.00	5,000.00	22,000.00		285,475.00
57	Texas (College Station).....	209,000.00				120,800.00
58	Texas (Prairie View).....				70,827.00	17,500.00
59	Utah.....	183,442.77				24,200.00
60	Vermont.....	135,500.00		531,573.00		76,000.00
61	Virginia (Blacksburg).....	344,312.00				61,200.00
62	Virginia (Hampton).....	172,156.00		1,803,852.57		75,000.00
63	Washington.....	168,463.00	348,775.00		1,601,240.00	32,000.00
64	West Virginia (Morgantown).....	115,104.17		1,600.00		250,000.00
65	West Virginia (Institute).....					15,600.00
66	Wisconsin.....	303,359.61	288,263.95	83,851.46	340.00	1,500,000.00
67	Wyoming.....	23,194.02	10,767.94	400.00	900,000.00	105,000.00
	Total.....	13,236,303.95	2,970,787.90	18,078,039.86	8,378,907.27	15,136,197.97

^a Including farm buildings.^b Including apparatus.^c Included under Massachusetts Agricultural College.^d Including other land-grant funds.

equipment of land-grant colleges, 1909.

Buildings.	Apparatus.	Machinery.	Library.	Live stock.	Miscellaneous.	Total.	
\$318,510.26	\$34,202.87	\$39,040.00	\$101,216.90	\$3,000.00		\$758,470.03	1
59,325.00	228.00	3,264.13	984.00	500.00	\$12,337.05	132,652.74	2
197,176.89	37,026.68	21,582.44	27,042.01	1,270.00		323,738.02	3
350,000.00	75,000.00	85,000.00	40,000.00	3,000.00	1,500.00	699,500.00	4
28,000.00	600.00	16,000.00	2,000.00		500.00	107,100.00	5
3,620,076.35						9,536,353.96	6
206,884.84	56,000.00	20,516.60	40,000.00	11,000.00	25,000.00	847,716.92	7
257,000.00	11,500.00	7,000.00	21,000.00	11,000.00	27,000.00	566,000.00	8
130,000.00	61,000.00	19,000.00	25,000.00	4,000.00	1,500.00	368,500.00	9
26,000.00	1,000.00	800.00	300.00	1,100.00	500.00	35,700.00	10
150,000.00	30,000.00	32,000.00	7,000.00	1,000.00	1,000.00	463,800.00	11
35,000.00	6,500.00	2,300.00	800.00	2,700.00	4,700.00	62,000.00	12
494,200.00	25,665.90	1,635.12	50,000.00	2,929.53	19,234.10	1,280,866.82	13
48,052.77	250.00	2,034.55	551.06	885.00	100.00	58,649.63	14
14,000.00	15,594.93		10,000.00			99,594.93	15
400,200.00	22,370.42	28,925.98	25,000.00	4,893.00	41,994.82	1,750,269.37	16
1,493,500.00	300,000.00	225,000.00	277,860.00	19,308.70	175,000.00	3,546,240.23	17
850,000.00		225,000.00	35,000.00	10,000.00	30,000.00	1,625,000.00	18
1,550,450.00		301,018.28	96,300.25	31,976.86	166,251.44	2,979,647.30	19
703,103.45	74,465.14	34,085.99	59,280.55	24,765.50	187,686.07	1,816,980.26	20
405,000.00	63,783.68	30,726.31	17,308.00		435,385.00	1,561,669.99	21
40,000.00	300.00	2,700.00	2,320.00	2,950.00		94,295.00	22
504,957.61	24,758.98	25,522.53	36,494.28	620.00	31,415.79	1,093,122.22	23
48,160.82	3,467.16	3,480.30	4,000.00	1,365.00	5,000.00	115,473.22	24
470,000.00	50,000.00	50,000.00	50,000.00	7,000.00	20,000.00	915,300.00	25
200,000.00	80,000.00		7,500.00	600.00	5,000.00	441,100.00	26
20,000.00	1,000.00	2,500.00	600.00	2,200.00	200.00	30,500.00	27
386,786.00	64,123.46	4,059.25	51,067.55	15,626.00	63,332.84	990,345.10	28
628,800.00		393,000.00	174,000.00			5,791,564.00	29
826,000.00	60,000.00	65,000.00	60,000.00	30,000.00		2,152,683.99	30
2,354,296.00	274,642.00	100,375.00	372,658.00	32,037.00	352,777.00	6,416,624.35	31
480,050.00	49,604.10	137,497.74	29,849.20	33,335.00	57,631.32	1,088,044.91	32
220,000.00	10,000.00	6,060.00	3,500.00	4,600.00		462,971.00	33
1,209,950.00	138,551.58	3,692.96	184,636.50	31,268.35	189,313.46	3,595,802.27	34
125,000.00	2,000.00	8,000.00	4,000.00	1,000.00	3,000.00	163,000.00	35
228,000.00	55,000.00	17,000.00	19,200.00	8,000.00	21,500.00	1,898,052.21	36
933,550.00	92,235.00	33,546.00	157,000.00	30,830.00	259,900.00	2,640,075.00	37
400,188.86	37,657.66	17,643.70	24,210.00	7,150.59	93,509.62	814,209.58	38
332,000.00	31,000.00	10,000.00	26,800.00	4,400.00	22,000.00	606,200.00	39
590,000.00	48,000.00		59,000.00		90,000.00	1,737,526.20	40
107,900.00	23,969.85	41,199.20	36,319.00	4,755.00	7,969.00	281,243.81	41
4,060,983.78			719,158.00		e1,215,457.84	15,095,213.76	42
269,900.00	24,612.00	101,491.00	7,500.00	5,857.00	44,965.13	639,325.13	43
75,160.00	2,561.00	16,938.00	2,161.51	3,165.00	10,520.61	137,506.12	44
380,000.00	21,000.00	19,000.00	23,707.00	10,500.00	10,500.00	1,864,250.42	45
1,375,000.00	350,000.00	100,000.00	350,000.00	15,000.00		4,637,961.64	46
200,000.00			22,710.00	7,500.00	f160,000.00	1,690,210.00	47
106,000.00	1,800.00	10,000.00	1,450.00	1,750.00	5,000.00	134,000.00	48
378,250.00	57,939.27	36,810.86	16,160.80	1,700.00		1,028,379.93	49
1,377,499.00	g150,000.00		60,000.00	3,070.00		2,163,569.00	50
65,850.00	2,000.00	14.00	2,515.00	5,400.00	5,670.00	113,449.00	51
188,716.57			26,429.60		f77,809.45	357,810.62	52
553,399.00	231,095.00	138,148.00	35,000.00	19,700.00		1,185,581.00	53
92,500.00	11,500.00	7,150.00	2,000.00	3,000.00	2,500.00	254,550.00	54
300,000.00	25,000.00	19,000.00	36,000.00	10,000.00	3,750.00	2,128,836.82	55
289,346.59	74,203.50	68,341.26	20,717.00	5,241.50	24,118.84	1,194,443.69	56
778,000.00	41,110.35	64,038.12	15,242.00	16,138.00	67,460.00	1,311,788.47	57
150,000.00	2,000.00	4,000.00	2,000.00	3,500.00	1,200.00	180,200.00	58
305,578.04	30,500.00	27,000.00	14,500.00	10,000.00	33,000.00	699,047.81	59
940,000.00	55,000.00	30,000.00	117,238.00	5,500.00	175,000.00	2,065,811.00	60
481,100.00			7,300.00		e120,000.00	1,013,912.00	61
700,000.00			10,000.00	14,383.00	b175,000.00	2,950,391.57	62
607,000.00	g118,150.00		51,100.00	10,200.00	1,600.00	2,938,528.00	63
600,000.00	20,000.00	48,000.00	78,400.00	5,085.00	10,000.00	1,128,189.17	64
119,600.00	4,549.00	14,475.00	5,000.00	1,908.00	11,746.00	172,878.00	65
2,283,126.08	379,472.07	20,477.44	318,652.75	26,763.00	137,182.43	5,341,488.79	66
270,000.00	90,000.00	37,600.00	52,000.00	5,820.00	12,000.00	1,506,781.96	67
38,389,127.91	3,553,989.51	2,803,629.76	4,136,738.96	542,246.03	4,656,717.81	111,882,686.96	

e Including apparatus, machinery, and live stock.

f Including apparatus and machinery.

g Including machinery.

TABLE 5.—Revenue of land-grant col

State or Territory.	Federal aid.			State aid.	
	Interest on land grant of 1862.	Interest on other land grants.	Appropriation acts of 1890 and 1907.	Interest on endowment or regular appropriation.	Appropriation for current expenses.
1 Alabama (Auburn).....	\$20,280.00		\$19,280.02		\$38,700.00
2 Alabama (Normal).....			15,719.98	\$4,000.00	
3 Arizona.....			35,000.00		33,000.00
4 Arkansas (Fayetteville).....	3,900.00		25,454.55		75,000.00
5 Arkansas (Pine Bluff).....			9,545.45		11,600.00
6 California.....	36,718.56	\$7,758.20	35,000.00	37,609.50	450,362.14
7 Colorado.....	11,497.40		35,000.00		72,578.34
8 Connecticut.....	6,750.00		35,000.00		25,000.00
9 Delaware (Newark).....	4,980.00		28,000.00		
10 Delaware (Dover).....			7,000.00		
11 Florida (Gainesville).....	4,994.00	1,975.50	17,500.00		19,844.07
12 Florida (Tallahassee).....			17,500.00		5,000.00
13 Georgia (Athens).....	16,954.14		23,333.34		50,000.00
14 Georgia (Savannah).....			11,666.66	8,000.00	
15 Hawaii.....			35,000.00		(a)
16 Idaho.....	4,772.94	25,352.67	35,000.00		44,750.00
17 Illinois.....	32,480.80		35,000.00		450,000.00
18 Indiana.....	17,000.00		35,000.00		171,401.79
19 Iowa.....	34,216.91		35,000.00		219,784.25
20 Kansas.....	26,056.72		35,000.00		155,000.00
21 Kentucky (Lexington).....	8,644.50		29,925.00		101,500.00
22 Kentucky (Frankfort).....	1,255.50		5,075.00		8,000.00
23 Louisiana (Baton Rouge).....	9,115.69	5,440.00	19,380.08		40,000.00
24 Louisiana (New Orleans).....			15,619.92		10,000.00
25 Maine.....	5,915.00		35,000.00		82,500.00
26 Maryland (College Park).....	5,797.16		28,000.00		15,000.00
27 Maryland (Princess Anne).....			7,000.00		
28 Massachusetts (Amherst).....	7,300.00		23,333.33	3,313.32	62,689.17
29 Massachusetts (Boston).....	5,306.68		11,666.67		25,000.00
30 Michigan.....	69,527.13		35,000.00		125,000.00
31 Minnesota.....	23,079.00		35,000.00	34,060.00	410,157.57
32 Mississippi (Agricultural College).....	5,914.50	8,472.75	17,764.83		65,946.36
33 Mississippi (Alcorn).....	6,814.50	5,777.77	17,235.17		8,000.00
34 Missouri (Columbia).....	17,494.10	12,320.00	32,812.50	33,097.86	390,144.83
35 Missouri (Jefferson City).....			2,187.50		85,000.00
36 Montana.....	11,093.70		35,000.00		38,500.00
37 Nebraska.....	29,000.00	11,000.00	35,000.00		391,735.00
38 Nevada.....	4,580.20	3,949.23	35,000.00		56,550.00
39 New Hampshire.....	4,800.00		35,000.00		13,000.00
40 New Jersey.....	5,800.00		35,000.00		28,500.00
41 New Mexico.....		2,425.29	35,000.00		16,440.63
42 New York.....	34,428.80		35,000.00		180,000.00
43 North Carolina (West Raleigh).....	7,500.00		23,450.00		37,000.00
44 North Carolina (Greensboro).....			11,550.00		10,000.00
45 North Dakota.....	50,493.42		35,000.00		44,564.74
46 Ohio.....	31,450.59	6,288.50	35,000.00		396,314.55
47 Oklahoma (Stillwater).....			31,500.00		41,000.00
48 Oklahoma (Langston).....			3,500.00		42,500.00
49 Oregon.....	17,237.04		35,000.00		50,000.00
50 Pennsylvania.....	25,637.43		35,000.00	5,382.57	114,000.00
51 Porto Rico.....			35,000.00	16,350.00	36,500.00
52 Rhode Island.....	2,500.00		35,000.00		25,000.00
53 South Carolina (Clemson College).....	5,754.00		17,500.00	112,881.95	
54 South Carolina (Orangeburg).....	5,754.00		17,500.00		8,000.00
55 South Dakota.....	16,035.45		35,000.00		41,000.00
56 Tennessee.....	23,960.00	250.00	35,000.00		
57 Texas (College Station).....	13,280.00		26,250.00		74,000.00
58 Texas (Prairie View).....			8,750.00		32,000.00
59 Utah.....	8,947.40		35,000.00		45,000.00
60 Vermont.....	8,130.00		35,000.00	2,600.00	6,000.00
61 Virginia (Blacksburg).....	20,658.00		23,333.33		60,000.00
62 Virginia (Hampton).....	10,329.36		11,666.67		
63 Washington.....	10,843.83	17,868.38	35,000.00		(c)
64 West Virginia (Morgantown).....	6,485.00		28,000.00		116,400.00
65 West Virginia (Institute).....			7,000.00		27,850.00
66 Wisconsin.....	16,653.63	13,243.32	35,000.00		750,360.70
67 Wyoming.....	5,156.96	5,610.98	35,000.00		26,377.37
Total.....	763,274.04	127,732.59	1,750,000.00	257,295.20	5,959,551.51

a Biennial appropriation of \$25,000 for 1907-1909 for building and maintenance reported last year.

b Including tuition fees.

c Including incidental fees.

leges for year ended June 30, 1909.

State aid.	Income from endowment other than federal or state grants.	Fees and all other sources.			Total.	United States appropriations for experiment stations (acts of 1887 and 1906).	
		Tuition fees.	Incidental fees.	Miscellaneous.			
\$56,500.00		\$1,940.00	\$3,172.00	\$21,151.50	\$161,023.52	\$26,000.00	1
					19,719.98		2
39,800.00	\$538.65	590.00	1,095.90	13,344.55	123,369.10	26,000.00	3
50,000.00			13,925.00	275.00	168,554.55	26,000.00	4
		500.00			21,645.45		5
205,228.76	129,152.73	26,780.44	71,239.80	479,813.36	1,479,663.49	26,000.00	6
				24,226.62	143,302.36	26,000.00	7
24,602.61	5,460.00			48,433.03	145,245.64	13,000.00	8
		60.00	7,774.14	1,250.00	42,064.14	26,000.00	9
			514.00		7,514.00		10
40,000.00		40.00	355.00		85,346.28	26,000.00	11
				590.11	23,090.11		12
16,043.44					106,330.92		13
					19,666.66		14
(a)					35,000.00		15
62,500.00				4,728.64	177,104.25	26,000.00	16
815,845.00			b 232,279.71	102,393.40	1,667,998.91	26,000.00	17
		10,337.50	53,628.00	74,551.71	361,919.00	26,000.00	18
184,773.16		6,191.67	53,433.55	3,563.35	536,962.89	26,000.00	19
92,250.00			15,503.00		323,809.72	26,000.00	20
		3,515.80	2,592.50	3,731.12	149,908.92	26,000.00	21
40,000.00			542.02	6,386.07	61,258.59		22
38,850.00		3,264.00	11,495.50	6,092.05	133,637.32	26,000.00	23
				363.50	25,983.42		24
50,000.00	4,000.00	36,144.00		5,000.00	218,559.00	26,000.00	25
30,000.00		22,768.42	11,545.00	2,613.48	115,724.06	26,000.00	26
			1,520.00	1,500.00	10,020.00		27
76,843.71		660.00		75,042.83	249,182.36	26,000.00	28
4,000.00	79,855.61	318,394.10		77,257.92	521,480.98		29
141,000.00		1,155.00	7,854.25	69,063.08	448,599.46	26,000.00	30
548,335.14		c 165,735.00		32,912.00	1,249,278.71	25,930.09	31
		610.00	9,208.89	33,715.49	141,632.82	26,000.00	32
40,216.00					78,043.44		33
30,121.95	300.00		49,194.70	33,980.48	599,466.42	26,000.00	34
		3,035.00	2,120.00	2,681.45	87,187.50		35
48,750.00		13,978.00	37,509.00	54,858.00	92,430.15	26,000.00	36
34,000.00	6,064.00		7,134.00	2,980.48	621,830.00	26,000.00	37
	4,048.90	5,124.00	4,078.44	25,174.40	150,257.91	26,000.00	38
20,000.00	23,926.11		18,936.76	31,198.84	91,225.74	26,000.00	39
56,164.85		2,025.50	22.40	6,672.13	163,361.71	26,000.00	40
13,921.63	394,132.80	352,555.08	123,845.41	280,970.43	118,750.80	26,000.00	41
5,000.00		16,212.15		19,330.50	1,414,854.15	23,850.00	42
4,425.00		352.00	464.00	6,808.00	108,492.65	26,000.00	43
130,000.00		4,750.00		6,906.31	31,599.00		44
158,872.78	15,362.38	64,274.17	11,669.94	64,492.66	271,714.47	26,000.00	45
87,000.00				61,652.91	783,725.57		46
					221,152.91	26,000.00	47
					46,000.00		48
50,975.12			20,905.75	2,070.83	176,188.74	26,000.00	49
28,000.00		1,550.00	36,188.84	80,571.00	326,329.84	26,000.00	50
71,000.00		2.50		912.86	159,765.36		51
		1,225.34	1,132.85	31,380.78	96,238.97	26,000.00	52
	3,512.36	2,212.23		3,978.22	145,838.76	26,000.00	53
							54
4,000.00					35,254.00		55
25,000.00		4,239.00	4,784.50	7,820.29	133,879.24	26,000.00	56
50,000.00	1,765.43	18,085.63		19,450.59	148,511.65	26,000.00	57
87,250.00			3,000.00	85,000.00	288,780.00	26,000.00	58
1,800.00			5,000.00	45,000.00	92,550.00		59
15,300.00		3,283.50	2,882.80	16,381.11	126,794.81	26,000.00	60
	31,507.00		28,200.96	5,605.81	117,043.77	26,000.00	61
16,000.00		2,525.00	30,248.00	4,696.00	157,460.33	26,000.00	62
	79,601.32		2,426.00	127,168.87	231,192.22		63
(f)				27,093.24	90,805.45	26,000.00	64
45,200.00	85.00	22,539.15	827.29	18,758.13	238,294.57	26,000.00	65
4,500.00			705.00	1,313.79	41,368.79		66
397,628.03	4,383.65	23,262.50	130,211.59	160,842.32	1,531,585.74	26,000.00	67
14,015.59	24.00		886.00	3,211.38	90,282.28	26,000.00	68
3,955,712.77	783,719.94	1,139,916.68	1,020,052.49	2,325,598.33	18,082,853.55	1,180,780.09	69

d Including income from other land grants.

e Appropriation of \$217,000 for biennium ended March 31, 1909, reported last year.

f Appropriation of \$370,500 for biennium ended March 31, 1909, reported last year.

TABLE 6.—*Additions to equipment of land-grant colleges, 1909.*

State or Territory.	Permanent endowment.	Buildings.	Library.	Apparatus.	Machinery.	Live stock.	Miscellaneous.	Total.
Alabama (Auburn).....		\$130,729.26	\$694.98	\$6,259.16	\$1,364.13	\$500.00		\$137,683.40
Alabama (Normal).....		1,871.92		1,770.93			\$1,140.38	6,647.36
Arizona.....	\$10,500.00	39,800.00	2,620.53	3,608.59	1,151.39			57,680.51
Arkansas (Fayetteville).....			800.00	2,500.00	2,000.00	1,000.00	500.00	6,800.00
Arkansas (Pine Bluff).....								
California.....	161,651.38	472,738.77	15,476.56	30,000.00	15,000.00	5,476.65		700,343.36
Colorado.....		16,633.84	3,000.00					19,633.84
Connecticut.....		23,231.53	258.24	891.42	1,344.32	1,726.04	435.10	27,886.65
Delaware (Newark).....			1,500.00	1,000.00	250.00	1,000.00	400.00	5,230.00
Florida (Gainesville).....						130.00		130.00
Florida (Tallahassee).....		980.00						
Georgia (Athens).....		575.00	723.38	2,327.39	2,034.67	420.75	913.97	6,995.16
Georgia (Savannah).....								
Hawaii.....	55,923.90		293.13	1,568.74	1,635.12	1,920.30	1,184.67	62,525.86
Hawaii.....	750.00							750.00
Idaho.....		5,000.00						24,211.92
Idaho.....	72,355.01	222,371.96	6,354.52	10,863.24			1,394.16	318,589.67
Illinois.....	3,694.00	200,000.00	87,800.00	3,979.07	8,370.46	263.50	5,249.67	354,862.70
Indiana.....		153,641.48	3,000.00	25,000.00	30,000.00	3,308.70	5,000.00	168,341.48
Iowa.....	88.00	176,391.65	2,640.59	10,925.11	9,200.00	13,140.45		203,180.80
Kansas.....		98,000.00	1,700.00	3,100.00	3,200.00	2,000.00	15,970.00	123,975.00
Kentucky (Lexington).....			2,862.48	3,212.08	644.31		911.38	60,980.04
Kentucky (Frankfort).....			150.00			350.00		500.00
Louisiana (Baton Rouge).....		28,224.45	2,764.34	7,169.92	2,334.21		4,211.19	44,704.11
Louisiana (New Orleans).....			10.00	97.50	486.30	565.00	300.00	1,458.80
Maine.....		53,000.00	4,000.00	10,000.00	1,000.00	500.00		68,500.00
Maryland (College Park).....		35,000.00	500.00	2,000.00		500.00	500.00	38,500.00
Maryland (Princess Anne).....			120.00	600.00	200.00	730.00	160.00	1,810.00
Massachusetts (Amherst).....								
Massachusetts (Boston).....		45,000.00		4,000.00			6,000.00	55,000.00
Michigan.....	15,000.00	19,400.37	2,000.00	5,000.00	4,000.00	6,000.00		34,400.37
Minnesota.....		175,000.00	28,639.00	11,789.00	6,000.00	3,776.00	307,938.00	192,000.00
Mississippi (Agricultural College).....		29,135.25						446,677.25
Mississippi (Alcorn).....		94,485.00	1,380.50	8,004.90	5,256.36	6,960.00	6,522.62	122,609.38
Missouri (Columbia).....		28,000.00	75.00		10,000.00	1,600.00		39,675.00
Missouri (Jefferson City).....			25,136.50			6,289.35		31,425.85
Montana.....			400.00					400.00
Nebraska.....	76,481.05		1,200.00	2,000.00		1,000.00		80,681.05
Nevada.....	42,000.00	110,000.00	9,000.00	6,000.00	2,500.00	3,000.00	12,000.00	184,500.00
New Hampshire.....		50,000.00	10,000.00	1,357.20	472.00	1,036.00		94,045.20
New Jersey.....			1,025.00	1,375.00	125.00			3,175.00
New Mexico.....	25,103.18	77,263.02	3,259.38	1,052.40	15,584.93		5,354.23	127,617.14
New York.....		42,960.00	930.00	994.85	2,699.20	502.75		48,086.80
North Carolina (West Raleigh).....		77,408.69	19,486.00				89,015.34	448,339.26
North Carolina (Greensboro).....			804.25	975.00	1,015.00	808.00		3,722.25
		4,630.00	135.00		570.00	210.00	989.00	6,534.00

North Dakota.....	4,924.31	1,707.00	1,374.74	2,273.20	677.74	1,907.19	12,864.18
Ohio.....	79,962.60	11,169.92	08,645.24	5,700.20	2,328.00	.....	256,520.90
Oklahoma (Stillwater).....	87,000.00	950.00	1,000.00	.....	400.00	300.00	87,000.00
Oklahoma (Langston).....	65,000.00	1,248.09	12,303.24	4,000.00	.....	.....	67,650.00
Oregon.....	46,888.50	.....	.....	.....	.....	.....	64,439.83
Pennsylvania.....	28,000.00	850.00	800.00	14.00	4,275.00	2,170.00	28,000.00
Porto Rico.....	23,500.00	905.95	1,676.16	225.05	345.33	.....	31,609.00
Rhode Island.....	900.00	.....	.....	.....	.....	.....	4,052.49
South Carolina (Clemson College).....	.....	.....	.....	.....	490.00	.....	3,885.73
South Carolina (Orangeburg).....	25,000.00	700.00	1,384.73	2,011.00	.....	.....	29,400.00
South Dakota.....	7,434.92	1,800.00	2,500.00	1,200.00	227.00	1,825.00	15,741.89
Tennessee.....	63,003.00	.....	2,632.70	1,822.27	2,500.00	.....	74,000.00
Texas (College Station).....	1,800.00	500.00	5,000.00	1,500.00	500.00	500.00	4,600.00
Texas (Prairie View).....	.....	1,338.50	400.00	900.00	802.39	1,867.24	5,454.18
Utah.....	.....	2,620.00	577.99	500.00	808.16	10,000.00	29,586.00
Vermont.....	.....	500.00	1,500.00	500.00	.....	20,000.00	25,000.00
Virginia (Blacksburg).....	4,500.00	900.00	.....	2,000.00	.....	.....	126,280.99
Virginia (Hampson).....	103,380.99	1,100.00	1,325.00	1,825.00	200.00	1,600.00	282,390.21
Washington.....	276,340.21	4,500.00	3,000.00	5,000.00	1,000.00	2,700.00	16,200.00
West Virginia (Morgantown).....	.....	200.00	100.00	.....	1,700.00	.....	3,362.15
West Virginia (Institute).....	1,362.15	27,052.53	23,439.04	2,733.83	1,917.80	30,384.30	489,436.64
Wisconsin.....	402,947.19	2,906.19	5,377.70	2,068.66	2,251.70	5,000.00	34,278.40
Wyoming.....	16,674.15	.....	.....	.....	.....	.....	.....
Total.....	3,411,201.44	307,807.46	303,238.04	163,013.00	86,454.22	638,518.44	6,055,146.80

^a Including apparatus.^b Including machinery.

TABLE 7.—Disbursements from the United States Treasury to the States and Territories of the appropriations in aid of colleges of agriculture and the mechanic arts under the acts of Congress approved August 30, 1890, and March 4, 1907. a

State or Territory.		Year ending June 30—													
		1890.	1891.	1892.	1893.	1894.	1895.	1896.	1897.	1898.	1899.	b 1900.	1909.	1910.	
	Alabama.....	\$15,000	\$16,000	\$17,000	\$18,000	\$19,000	\$20,000	\$21,000	\$22,000	\$23,000	\$24,000	\$25,000	\$30,000	\$35,000	\$40,000
	Arizona.....	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000	30,000	35,000	40,000
	Arkansas.....	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000	30,000	35,000	40,000
	California.....	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000	30,000	35,000	40,000
	Colorado.....	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000	30,000	35,000	40,000
	Connecticut.....	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000	30,000	35,000	40,000
	Delaware.....	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000	30,000	35,000	40,000
	Florida.....	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000	30,000	35,000	40,000
	Georgia.....	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000	30,000	35,000	40,000
	Hawaii.....														
	Idaho.....	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000	30,000	35,000	40,000
	Illinois.....	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000	30,000	35,000	40,000
	Indiana.....	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000	30,000	35,000	40,000
	Iowa.....	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000	30,000	35,000	40,000
	Kansas.....	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000	30,000	35,000	40,000
	Kentucky.....	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000	30,000	35,000	40,000
	Louisiana.....	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000	30,000	35,000	40,000
	Maine.....	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000	30,000	35,000	40,000
	Maryland.....	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000	30,000	35,000	40,000
	Massachusetts.....	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000	30,000	35,000	40,000
	Michigan.....	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000	30,000	35,000	40,000
	Minnesota.....	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000	30,000	35,000	40,000
	Mississippi.....	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000	30,000	35,000	40,000
	Missouri.....	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000	30,000	35,000	40,000
	Montana.....		16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000	30,000	35,000	40,000
	Nevada.....	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000	30,000	35,000	40,000
	New Hampshire.....	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000	30,000	35,000	40,000
	New Jersey.....	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000	30,000	35,000	40,000
	New Mexico.....	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000	30,000	35,000	40,000
	New York.....	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000	30,000	35,000	40,000
	North Carolina.....	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000	30,000	35,000	40,000
	North Dakota.....	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000	30,000	35,000	40,000
	Ohio.....	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000	30,000	35,000	40,000
	Oklahoma.....		16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000	30,000	35,000	40,000
	Oregon.....	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000	30,000	35,000	40,000
	Pennsylvania.....	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000	30,000	35,000	40,000
	Porto Rico.....														
	Rhode Island.....	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000	30,000	35,000	40,000
	South Carolina.....	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000	30,000	35,000	40,000
	South Dakota.....	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000	30,000	35,000	40,000

Tennessee.....	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000	30,000	35,000	40,000
Texas.....	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000	30,000	35,000	40,000
Utah.....	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000	30,000	35,000	40,000
Vermont.....	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000	30,000	35,000	40,000
Virginia.....	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000	30,000	35,000	40,000
Washington.....	.....	.....	.....	.....	19,000	20,000	21,000	22,000	23,000	24,000	25,000	30,000	35,000	40,000
West Virginia.....	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000	30,000	35,000	40,000
Wisconsin.....	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000	30,000	35,000	40,000
Wyoming.....	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000	30,000	35,000	40,000
Total.....	660,000	704,000	782,000	864,000	912,000	960,000	1,008,000	1,056,000	1,104,000	1,152,000	1,200,000	1,440,000	1,750,000	2,000,000

^a From the annual statement of the Commissioner of Education to the Secretary of the Interior, 1909.

^b For each of the years ended June 30, 1901, 1902, 1903, 1904, 1905, 1906, and 1907 the sum of \$25,000 was paid to each of the 48 States and Territories included in this tabular statement, the total amount disbursed for each of said years being \$1,200,000.

STATISTICS OF AGRICULTURAL

TABLE 8.—*General*

Station.	Location.	Director.	Date of original organization.	Date of organization under Hatch Act.
Alabama (College).....	Auburn.....	J. F. Duggar, M. S....	Feb. —, 1883	Feb. 24, 1888
Alabama (Canebrake)...	Uniontown.....	F. D. Stevens, B. S...	Jan. 1, 1886	Apr. 1, 1888
Alabama.....	Tuskegee Institute....	G. W. Carver, M. S. Agr.	Feb. 15, 1897	.....
Arizona.....	Tucson.....	R. H. Forbes, M. S....	.....	1889
Arkansas.....	Fayetteville.....	C. F. Adams, B. Agr., A. M., M. D.	.....	Mar. 7, 1889
California.....	Berkeley.....	E. J. Wickson, A. M..	1873	Mar. —, 1888
Colorado.....	Fort Collins.....	L. G. Carpenter, M. S.	.....	Feb. —, 1888
Connecticut (State).....	New Haven.....	E. H. Jenkins, Ph. D..	Oct. 1, 1875	May 18, 1887
Connecticut (Storrs).....	Storrs.....	L. A. Clinton, M. S...	.....	do.....
Delaware.....	Newark.....	Harry Hayward, M. S. Agr.	.....	Feb. 21, 1888
Florida.....	Gainesville.....	P. H. Rolfs, M. S....	.....	1888
Georgia.....	Experiment.....	M. V. Calvin.....	Feb. 18, 1888	July 1, 1889
Idaho.....	Moscow.....	W. L. Carlyle, M. S...	.....	Feb. 26, 1892
Illinois.....	Urbana.....	Eugene Davenport, M. Agr., LL. D.	.....	Mar. 21, 1888
Indiana.....	Lafayette.....	Arthur Goss, M. S., A. C.	.....	Jan. 1, 1888
Iowa.....	Ames.....	C. F. Curtiss, M. S., A. D. S.	.....	Feb. 17, 1888
Kansas.....	Manhattan.....	E. H. Webster, B. Agr., M. S.	.....	Feb. 8, 1888

EXPERIMENT STATIONS.*statistics, 1909.*

Number on staff.	Number of teachers on staff.	Number of persons on staff who assist in farmers' institutes.	Publications during fiscal year 1909.		Number of names on mailing list.	Principal lines of work.
			Number.	Pages.		
19	14	15	6	204	17,500	Field experiments; plant breeding; soil improvement; feeding experiments; entomology; diseases of plants and animals; analyses of fertilizers.
1	-----	-----	1	20	1,800	Soil improvement; field experiments; horticulture; plant breeding; diseases of plants.
20	19	21	1	11	1,600	Field experiments; horticulture; plant breeding; diseases of plants; animal industry; poultry investigations; dairying.
12	2	6	14	248	9,000	Botany; field experiments; improvement of ranges; horticulture, including date-palm culture; sheep-breeding experiments; plant diseases; irrigation; dry farming.
20	14	9	5	84	22,000	Chemistry; soil physics; field experiments; horticulture; plant breeding; diseases of plants; animal husbandry and pathology; feeding and breeding experiments; entomology; nursery inspection; dairying; poultry experiments.
54	27	18	14	396	16,000	Chemistry; soils; bacteriology; fertilizer control; field experiments; horticulture, viticulture, and zymology; botany; meteorology; animal husbandry; entomology; dairying; poultry culture; drainage and irrigation; silviculture; reclamation of alkali lands; animal and plant pathology; nutrition investigations.
20	9	13	27	654	16,590	Chemistry; meteorology; field experiments; horticulture; forestry; plant breeding; diseases of plants; animal husbandry; veterinary investigations; entomology; bacteriology; irrigation.
16	-----	6	4	552	9,700	Chemistry; analysis and inspection of fertilizers, foods, drugs, and feeding stuffs; inspection of Babcock-test apparatus and nurseries; diseases of plants; plant selection and breeding; seed testing; forestry; field experiments; entomology; investigation of vegetable proteids.
12	5	5	6	707	9,000	Bacteriology of dairy products; field experiments; horticulture; feeding and breeding experiments; poultry experiments; dairying, including soft-cheese manufacture; embryology.
10	4	4	5	129	7,000	Chemistry; field experiments; horticulture; plant breeding; diseases of plants and animals; animal husbandry.
15	-----	6	6	230	13,900	Chemistry; soils; field experiments; horticulture; plant physiology; diseases of plants; feeding experiments; entomology.
9	-----	-----	6	476	7,250	Chemistry; field experiments; bacteriology; horticulture; plant breeding; plant diseases; entomology; feeding experiments; dairying.
10	6	7	5	120	5,314	Chemistry; physics; bacteriology; botany; field experiments; horticulture; plant breeding and diseases; entomology; animal husbandry; irrigation; dairying; dry farming; wheat investigations; fruit by-products; veterinary science.
58	24	24	21	826	41,000	Chemistry; soil physics; bacteriology; pot and field experiments; horticulture; forestry; plant breeding; animal husbandry; diseases of plants and animals; dairying; entomology.
41	9	5	12	639	30,442	Chemistry; soils; field experiments; breeding and feeding experiments; horticulture; plant breeding; diseases of plants and animals; entomology; dairying; feeding stuff and fertilizer control; agricultural extension work.
31	13	5	4	134	21,500	Chemistry; botany; soils; field experiments; horticulture; plant breeding; forestry; diseases of plants; animal husbandry; poultry investigations; entomology; dairying; rural engineering; good roads investigations.
41	30	19	4	259	28,000	Soils; inspection of feeding stuffs and fertilizer control; horticulture; plant breeding; field experiments; feeding and digestion experiments; milling and baking tests; correlation of characteristics of wheat; poultry experiments; diseases of animals; hog-cholera serum; entomology; dairying; extermination of prairie dogs and gophers; irrigation.

TABLE 8.—*General statis*

Station.	Location.	Director.	Date of original organization.	Date of organization under Hatch Act.
Kentucky.....	Lexington.....	M. A. Scovell, M. S., Ph. D.	Sept. —, 1885	Apr. —, 1888
Louisiana (Sugar).....	New Orleans.....	W. R. Dodson, A. B., B. S.	Sept. —, 1885	1888 July 1, 1908
Louisiana (State).....	Baton Rouge.....	do.....	Apr. —, 1886	
Louisiana (North).....	Calhoun.....	do.....	May —, 1887	
Louisiana (Rice).....	Crowley.....	do.....		
Maine.....	Orono.....	C. D. Woods, Sc. D..	Mar. —, 1885	Oct. 1, 1887
Maryland.....	College Park.....	H. J. Patterson, B. S..	1888	Mar. 9, 1888
Massachusetts.....	Amherst.....	W. P. Brooks, Ph. D..	^a 1882	Mar. 2, 1888
Michigan.....	East Lansing.....	R. S. Shaw, B. S. A..		Feb. 26, 1888
Minnesota.....	St. Anthony Park, St. Paul	A. F. Woods, M. A. . .	Mar. 7, 1885	1888
Mississippi.....	Agricultural College...	W. L. Hutchinson, M. S.		Jan. 27, 1888
Missouri (College).....	Columbia.....	F. B. Mumford, M. S..		Jan. —, 1888
Missouri (Fruit).....	Mountain Grove.....	Paul Evans.....	Feb. 1, 1900	
Montana.....	Bozeman.....	F. B. Linfield, B. S. A.		July 1, 1893
Nebraska.....	Lincoln.....	E. A. Burnett, B. S. . .	Dec. 16, 1884	June 14, 1887
Nevada.....	Reno.....	J. E. Stubbs, M. A., D. D., LL. D.		Dec. —, 1887
New Hampshire.....	Durham.....	E. D. Sanderson, B. S. A.		Aug. 4, 1887
New Jersey (State).....	New Brunswick.....	E. B. Voorhees, D. Sc..	Mar. 10, 1880	
New Jersey (College).....	do.....	do.....		Apr. 26, 1888

^a In 1882 the State organized a station here and maintained it until June 18, 1895, when it was combined with the Hatch Station at the same place.

tics, 1909—Continued.

Number on staff.	Number of teachers on staff.	Number of persons on staff who assist in farmers' institutes.	Publications during fiscal year 1909.		Number of names on mailing list.	Principal lines of work.
			Number.	Pages.		
26	1	6	10	971	12,000	Chemistry; soils; bacteriology; inspection of fertilizers, foods, feeding stuffs, seeds, orchards, and nurseries; field experiments; horticulture; plant breeding; animal husbandry; diseases of plants and animals; entomology; apiculture; dairying.
26	2	-----	11	655	14,000	Chemistry; bacteriology; soils; field experiments; horticulture; sugar making; drainage; irrigation.
						Geology; botany; bacteriology; soils; inspection of fertilizers, feeding stuffs, and Paris green; field experiments; horticulture; fertilizer and variety tests with rice; animal husbandry; diseases of animals; entomology.
22	-----	-----	26	842	17,700	Chemistry; soils; fertilizers; field experiments; horticulture; feeding experiments; stock raising; poultry experiments; dairying.
18	6	8	9	331	23,000	Rice experiments.
27	9	4	16	474	20,000	Chemistry; botany; analysis and inspection of foods, fertilizers, concentrated commercial feeding stuffs, and agricultural seeds; calibration of creamery glassware; horticulture; vegetable pathology; biology including poultry breeding; plant breeding; entomology.
25	14	9	11	643	50,000	Chemistry; fertilizers; field experiments; horticulture; plant breeding; diseases of plants and animals; feeding experiments; animal breeding; poultry raising; entomology; dairying.
26	16	1	9	383	15,730	Chemistry; meteorology; analysis and inspection of fertilizers and concentrated commercial feeding stuffs; inspection of creamery glassware and nurseries; pot, cylinder, and field experiments; horticulture; plant breeding; diseases of plants and animals; digestion and feeding experiments; entomology; dairying; effect of electricity on plant growth.
19	6	12	13	344	24,000	Chemistry; analysis and control of fertilizers; bacteriology; field experiments; horticulture; forestry; plant breeding; diseases of plants and animals; feeding and breeding experiments; poultry culture; entomology; stable hygiene.
38	27	20	1	30	10,000	Chemistry; soils; fertilizers; field experiments; horticulture; forestry; diseases of plants and animals; plant and animal breeding; animal nutrition; entomology; dairying; farm management; ventilation; farm statistics.
4	-----	-----	7	290	6,000	Fertilizers; field experiments; horticulture; biology; plant breeding; animal husbandry; diseases of animals; poultry culture; entomology; dairying; agricultural engineering.
19	9	8	6	185	7,500	Chemistry; soil survey; botany; field experiments; horticulture; diseases of plants and animals; feeding experiments; animal and plant breeding; entomology; dairying.
13	14	16	5	368	20,500	Horticulture; vegetable pathology; entomology; inspection of orchards and nurseries.
14	6	10	4	183	4,000	Chemistry; meteorology; botany; field experiments; dry farming; horticulture; feeding and breeding experiments; poultry experiments; entomology; dairying; irrigation and drainage.
12	10	12	9	544	13,000	Chemistry; botany; meteorology; soils; field experiments; horticulture; plant breeding; diseases of plants and animals; forestry; feeding and breeding experiments; entomology; dairying; irrigation.
14	3	4	9	309	8,783	Chemistry; meteorology; botany; soils; field experiments; horticulture; plant breeding; forestry; animal feeding and breeding; plant diseases; veterinary science and bacteriology; zoology; entomology; irrigation.
10	5	3	5	439		

b Including substations.

TABLE 8.—*General statis*

Station.	Location.	Director.	Date of original organization.	Date of organization under Hatch Act.
New Mexico.....	Agricultural College...	Luther Foster, M. S. A.		Dec. 14, 1889
New York (State).....	Geneva.....	W. H. Jordan, D. Sc., LL. D.	Mar. —, 1882	
New York (Cornell).....	Ithaca	H. J. Webber, ^a Ph. D.	1879	Apr. —, 1888
North Carolina (College).	West Raleigh.....	C. B. Williams, M. S. ...	Mar. 12, 1877	Mar. 7, 1887
North Carolina (State)...	Raleigh.....	B. W. Kilgore, M. S. ...	July 1, 1907	
North Dakota.....	Agricultural College...	J. H. Worst, LL. D.		Mar. —, 1890
Ohio.....	Wooster.....	C. E. Thorne, M. S. A. ...	Apr. 25, 1882	Apr. 2, 1888
Oklahoma.....	Stillwater.....	J. A. Craig, B. S. A.		Dec. 25, 1890
Oregon.....	Corvallis.....	James Withycombe, M. Agr.		July —, 1888
Pennsylvania.....	State College.....	T. F. Hunt, D. Agr., D. Sc.		June 30, 1887
Rhode Island.....	Kingston.....	H. J. Wheeler, Ph. D.		July 30, 1888
South Carolina.....	Clemson College.....	J. N. Harper, B. S., M. Agr.		Jan. —, 1888
South Dakota.....	Brookings.....	J. W. Wilson, M. S. A.		Mar. 13, 1887
Tennessee.....	Knoxville.....	H. A. Morgan, B. S. A. ...	June 8, 1882	Aug. 4, 1887
Texas.....	College Station.....	H. H. Harrington.....		Jan. 25, 1888
Utah.....	Logan.....	E. D. Ball, Ph. D.		1890
Vermont.....	Burlington.....	J. L. Hills, Sc. D.	Nov. 24, 1886	Feb. 28, 1888

^a Acting Director.

tics, 1909—Continued.

Number on staff.	Number of teachers on staff.	Number of persons on staff who assist in farmers' institutes.	Publications during fiscal year 1909.		Number of names on mailing list.	Principal lines of work.
			Number.	Pages.		
14	16	2	5	278	3,226	Chemistry; botany; soils; field experiments; dry farming; horticulture; cactus and guayule plant investigations; feeding experiments; entomology; dairying; irrigation.
31	-----	16	26	2,227	43,000	Chemistry; bacteriology; meteorology; fertilizers; analysis and control of fertilizers; inspection of feeding stuffs, Paris green, and creamery glassware; field experiments; horticulture; plant breeding; diseases of plants; feeding experiments; poultry experiments; entomology; dairying; irrigation.
37	-----	-----	10	540	21,378	Chemistry; soils; field experiments; horticulture; plant breeding; diseases of plants; feeding and breeding experiments; poultry experiments; entomology; dairying.
17	7	5	5	117	14,000	Chemistry; soils; field experiments; horticulture; nitrification experiments; diseases of plants and animals; animal husbandry; poultry experiments; dairying; tests of farm machinery.
26	-----	10	12	614	35,000	Chemistry; soils; field experiments; horticulture; diseases of animals; feeding experiments; entomology; fertilizer experiments and analyses; inspection of foods and stock feeds; cooperative demonstration work with farmers; farmers' institutes.
28	19	5	9	615	15,000	Chemistry; soils; botany; field experiments; plant breeding; horticulture; forestry; diseases of plants and animals; analysis of foods and spraying materials; inspection and analysis of paints, drugs, proprietary products and feeding stuffs; feeding and breeding experiments; poultry experiments; milling and chemical tests of wheat; drainage; farm engineering.
37	-----	23	24	637	38,000	Chemistry; soils; field experiments; botany; horticulture; plant breeding; forestry; diseases of plants; feeding experiments; entomology; nutrition; farm management.
15	10	9	4	80	24,000	Chemistry; field experiments; horticulture; forestry; botany; bacteriology; animal husbandry; dairying; veterinary science; entomology.
34	16	8	8	222	10,000	Chemistry; bacteriology; soils; fertilizers; field crops; horticulture; plant breeding and selection; diseases of plants; feeding experiments; poultry experiments; entomology; dairying; irrigation.
38	19	15	6	404	19,041	Chemistry; meteorology; fertilizers; horticulture; forestry; plant diseases; field experiments; feeding experiments; dairying; poultry experiments.
17	4	3	8	350	10,500	Chemistry; meteorology; soils; analysis and inspection of fertilizers and feeding stuffs; field and pot experiments; horticulture; poultry and pigeon breeding; poultry husbandry.
12	-----	4	8	271	13,400	Chemistry; analysis and control of fertilizers; soils; botany; field experiments; horticulture; plant breeding; diseases of plants; feeding and breeding experiments; veterinary science; entomology; dairying.
23	14	5	7	172	15,000	Chemistry; botany; horticulture; field experiments; plant breeding; diseases of plants and animals; animal husbandry; dairying.
22	9	9	8	291	12,750	Chemistry; soil investigations; inspection of fertilizers; field experiments; horticulture; plant breeding; seeds; weeds; diseases of plants and animals; feeding experiments; entomology; dairying; poultry investigations; apiculture.
19	7	2	13	283	30,000	Chemistry; seed testing and feed inspection; botany and mycology; soils; field experiments; horticulture; plant breeding; feeding experiments; diseases of plants and animals; entomology; irrigation.
18	11	10	1	39	8,200	Chemistry of soils; field experiments; horticulture; diseases of plants and animals; breeding and feeding experiments; dairying; poultry experiments; entomology; irrigation; arid farming.
16	7	8	10	500	13,500	Chemistry; botany; bacteriology; analysis and control of fertilizers and feeding stuffs; inspection of creamery glassware; state nursery for forest-tree seedlings; horticulture; diseases of plants; feeding and breeding experiments; dairying.

TABLE 8.—*General statis*

Station.	Location.	Director.	Date of original organization.	Date of organization under Hatch Act.
Virginia.....	Blacksburg.....	S. W. Fletcher, Ph. D.		Oct. 16, 1888
Virginia (Truck)	Norfolk.....	T. C. Johnson, B. S. Agr., A. M.	Feb. —, 1907	
Washington.....	Pullman.....	R. W. Thatcher, B. S., M. A.		1891
West Virginia.....	Morgantown.....	J. H. Stewart, M. A.		1887
Wisconsin.....	Madison.....	H. L. Russell, Ph. D.	1883	1887
Wyoming.....	Laramie.....	J. D. Towar, M. S.		Mar. 1, 1891
Total.....				

tics, 1909—Continued.

Number on staff.	Number of teachers on staff.	Number of persons on staff who assist in farmers' institutes.	Publications during fiscal year 1909.		Number of names on mailing list.	Principal lines of work.
			Number.	Pages.		
17	7	5	11	328	23,000	Chemistry; biology; field experiments; horticulture; plant breeding; soil bacteriology; mycology; breeding and feeding experiments; cider and vinegar making; ferments; dairying.
4	.....	1	2	16	5,500	Field experiments; plant breeding; plant diseases; entomology.
24	12	8	19	228	12,611	Chemistry; botany; bacteriology; soils; field experiments; horticulture; plant breeding; diseases of plants; feeding and breeding experiments; veterinary science; entomology; irrigation; dry farming.
15	1	3	7	183	6,664	Chemistry; effect of pressure in the preservation of fruits, vegetables, and milk; artificial fixation of atmospheric nitrogen; analysis and control of fertilizers; soils; field experiments; horticulture; diseases of plants and animals; inspection of orchards and nurseries; feeding and breeding experiments; poultry experiments; entomology; dairying.
64	31	10	17	426	30,000	Chemistry; bacteriology; soils; field experiments; agronomy; tobacco and cranberry culture; horticulture; plant breeding; breeding and feeding experiments; dairying; irrigation and drainage; agricultural engineering.
12	8	8	5	177	5,000	Chemistry; mycology; botany; meteorology; soils; range improvement; fertilizers; field experiments; plant selection; food analysis; breeding and feeding experiments; wool investigation; veterinary science; irrigation.
1,242	502	445	517	21,678	912,579	

TABLE 9.—Revenue and addi

	Station.	Federal.		State.	Individuals and communities.	Fees.	Farm products.
		Hatch fund.	Adams fund.				
1	Alabama (College).....	\$15,000.00	\$11,000.00				
2	Alabama (Canebrake).....			\$2,500.00			
3	Alabama (Tuskegee).....			1,500.00			\$1,550.45
4	Arizona.....	15,000.00	11,000.00	<i>b</i> 13,100.00	\$2,400.00		
5	Arkansas.....	15,000.00	11,000.00	2,588.17			2,648.54
6	California.....	15,000.00	11,000.00	99,067.90		\$11,732.28	24,907.14
7	Colorado.....	15,000.00	11,000.00	<i>c</i> 2,500.00			
8	Connecticut (State).....	7,500.00	5,500.00	17,500.00	5,895.88	8,970.02	205.13
9	Connecticut (Storrs).....	7,500.00	5,500.00	1,800.00			
10	Delaware.....	15,000.00	11,000.00				1,984.63
11	Florida.....	15,000.00	11,000.00			80.00	833.91
12	Georgia.....	15,000.00	11,000.00	710.10			4,612.47
13	Idaho.....	15,000.00	11,000.00				2,052.17
14	Illinois.....	15,000.00	11,000.00	102,500.00			14,576.05
15	Indiana.....	15,000.00	11,000.00	53,194.44			
16	Iowa.....	15,000.00	11,000.00	25,000.00			10,224.56
17	Kansas.....	15,000.00	11,000.00	<i>d</i> 25,000.00	8,306.15		7,234.47
18	Kentucky.....	15,000.00	11,000.00	<i>e</i> 22,784.32	<i>f</i> 33,281.39		11,283.37
19	Louisiana.....	15,000.00	11,000.00	9,166.65	11,846.65		4,360.65
20	Maine.....	15,000.00	11,000.00		9,500.00		2,902.00
21	Maryland.....	15,000.00	11,000.00	7,500.00			4,734.47
22	Massachusetts.....	15,000.00	11,000.00	13,500.00	5,210.00		2,387.57
23	Michigan.....	15,000.00	11,000.00	<i>g</i> 5,158.91	3,802.50		
24	Minnesota.....	15,000.00	11,000.00	<i>g</i> 59,194.12			<i>g</i> 13,380.28
25	Mississippi.....	15,000.00	11,000.00	<i>d</i> 19,150.00		130.00	<i>g</i> 13,907.90
26	Missouri (College).....	15,000.00	11,000.00	1,473.87		9,051.27	3,071.75
27	Missouri (Fruit).....			<i>h</i> 33,600.00			
28	Montana.....	15,000.00	11,000.00	10,712.99	4,561.49		5,090.27
29	Nebraska.....	15,000.00	11,000.00				23,831.54
30	Nevada.....	15,000.00	11,000.00				1,355.40
31	New Hampshire.....	15,000.00	11,000.00				
32	New Jersey (State).....			<i>i</i> 38,806.18			
33	New Jersey (College).....	15,000.00	11,000.00				
34	New Mexico.....	15,000.00	11,000.00			100.15	4,213.22
35	New York (State).....	1,500.00	1,100.00	122,328.09			
36	New York (Cornell).....	13,500.00	9,900.00				
37	North Carolina (College).....	15,000.00	11,000.00				2,903.88
38	North Carolina (State).....			120,000.00			
39	North Dakota.....	15,000.00	11,000.00	12,386.25			
40	Ohio.....	15,000.00	11,000.00	118,990.00			12,047.04
41	Oklahoma.....	15,000.00	11,000.00	2,500.00			
42	Oregon.....	15,000.00	11,000.00	1,566.84			
43	Pennsylvania.....	15,000.00	11,000.00			19,070.75	10,681.85
44	Rhode Island.....	15,000.00	11,000.00		3.50		
45	South Carolina.....	15,000.00	11,000.00				2,976.11
46	South Dakota.....	15,000.00	11,000.00	2,000.00			3,169.36
47	Tennessee.....	15,000.00	11,000.00			1,000.00	8,058.55
48	Texas.....	15,000.00	11,000.00	<i>d</i> 7,000.00			
49	Utah.....	15,000.00	11,000.00	9,024.92			4,488.23
50	Vermont.....	15,000.00	11,000.00	1,000.00	339.06	2,745.00	
51	Virginia (College).....	15,000.00	11,000.00	5,000.00			694.10
52	Virginia (Norfolk).....			<i>j</i> 10,000.00			
53	Washington.....	15,000.00	11,000.00	<i>k</i> 26,500.00			1,753.70
54	West Virginia.....	15,000.00	11,000.00	10,000.00		11,030.81	7,727.32
55	Wisconsin.....	15,000.00	11,000.00	18,500.00		8,469.55	
56	Wyoming.....	15,000.00	11,000.00				2,332.40
Total.....		720,000.00	528,000.00	1,034,803.75	13,199.93	144,326.52	220,001.76

a Including all balances.*b* For biennium 1909-1911.*c* Part of 1909-10 appropriation.*d* For substations.*e* Appropriation of \$23,285.05 less deficit of \$500.73 from previous year.*f* Including balance of \$2,214.83 and minus deficit of \$2,869.68 from previous year.

tions to equipment, 1909.

Miscellaneous. ^a	Total.	Additions to equipment.						Total.	
		Buildings.	Library.	Apparatus.	Farm implements.	Live stock.	Miscellaneous.		
	\$26,000.00	\$975.00	\$300.00	\$1,825.00	\$20.00	\$75.00	\$715.00	\$3,910.00	1
\$1,087.56	5,138.01				350.00		650.00	1,000.00	2
	1,500.00		50.00		118.00		66.00	234.00	3
3,729.24	47,050.52	272.12	68.26	386.12	367.13	285.87	205.61	1,585.11	4
21,667.83	52,904.54	581.86	47.14	886.14	168.42	193.34	1,032.51	2,909.41	5
49,191.54	210,898.86	57,792.11	607.25	2,729.47	2,993.84	5,476.65	4,653.23	74,252.55	6
32,376.89	60,876.89	6,096.13	241.88	653.25	81.30	1,067.03	810.71	8,950.30	7
740.63	46,311.66	1,100.67	1,027.30	31.07	48.21			2,207.25	8
649.24	15,449.24	1,817.41	83.10	171.56	160.13	34.50		2,266.70	9
228.90	28,213.53	5,000.00	285.43	349.92	609.59	597.93		6,842.87	10
16.50	26,930.41	207.08	299.18	374.51	404.38		797.49	2,082.64	11
1,341.09	32,663.66	4,470.22	310.40	1,074.95	101.08	636.00	900.00	7,492.65	12
	28,052.17	1,587.29	74.40	1,255.15	650.45	355.00		3,922.29	13
20,489.08	163,565.13	6,000.00	26.99	621.35	1,458.12	1,352.37		9,458.83	14
45,495.50	124,689.94	13,913.04	724.68	1,982.75	1,411.55	8,953.48	23,179.51	50,165.01	15
2,933.51	64,158.07	1,468.69		491.76	605.23	1,750.95		4,316.63	16
7,316.60	73,857.22	469.51	12.30	1,135.22	661.52	414.68		2,693.23	17
349.14	98,098.22	1,133.90	799.03	1,417.95	186.00	176.50	736.70	4,450.08	18
6,176.05	57,550.00	11,431.16	629.78	1,678.55	1,650.41	1,202.34		16,592.24	19
1,830.41	40,232.41	1,200.00	965.00	1,085.00	605.00	540.00		4,395.00	20
3,407.63	41,642.10	1,082.72	569.05	551.92	342.75	420.26	892.13	3,858.83	21
12,354.69	59,452.26	681.39	456.60	1,192.68	10.07	22.25	110.00	2,502.99	22
9,475.87	44,437.28	1,598.34	585.24	1,972.90	65.51	1,710.87		5,932.86	23
	98,574.40			105.10	1,156.36	528.97	50,870.94	52,661.37	24
4,398.49	63,586.39	13,980.00	300.00		400.00	4,950.00	2,370.00	22,000.00	25
2,952.42	42,549.31	110,000.00	1,000.00	2,500.00	500.00	2,500.00		116,500.00	26
	33,600.00		500.00	2,000.00			1,000.00	3,500.00	27
	46,364.75	80,000.00	289.40	805.82	797.62	859.47	25,713.04	108,465.35	28
6,858.58	56,690.12	12,500.00		1,167.74	275.55	6,000.00		19,943.29	29
673.48	28,028.88	429.32	679.03	1,707.65	317.80	910.91	2,165.91	6,210.62	30
4,078.44	30,078.44	793.95	505.94	317.12	224.47	102.50	775.92	2,719.90	31
	38,806.18		48.15	963.74			59.75	1,071.64	32
	26,000.00	1,023.02	864.18	157.71	474.53		354.23	2,873.67	33
1,300.00	31,613.37	12,241.61	14.03	223.85	2,080.13	725.00		15,284.62	34
7,230.78	132,158.87	34,414.11	970.49			150.75		35,535.35	35
	23,400.00	429.21	308.74	1,726.56	64.08			2,528.59	36
1,840.30	30,744.18	2,500.47	107.38	178.25	314.76	738.00		3,838.86	37
	120,000.00	2,000.00	500.00	250.00	500.00			3,250.00	38
10,818.57	49,204.82	27,350.31	1,707.00	1,374.74	2,273.20	1,138.54	1,907.19	35,750.98	39
70,043.09	227,080.13	964.67	1,480.24	1,345.29	1,216.91	2,601.75		7,608.86	40
33,460.44	61,960.44	665.82	250.80	152.55	239.70	3,423.47		4,732.34	41
3,041.44	30,608.28	12.79	2.00	169.00	324.25	294.15		802.19	42
5,715.31	61,467.91		39.36	1,107.47	163.02	210.00	214.63	1,734.48	43
6,446.23	32,449.73	30.88	593.90	136.09	135.59	142.74	759.03	1,798.23	44
2,101.07	31,077.18	859.44	129.41	199.01	309.00	179.60		1,676.46	45
2,948.91	34,118.27		169.00	940.00	50.25	425.00		1,584.25	46
	35,058.55		418.89	2,524.82	183.49	197.00	495.73	3,819.93	47
1,086.47	34,086.47	904.33	185.58	140.92	571.15	235.00	933.92	2,970.90	48
1,130.75	40,643.90	104.45	235.27	388.72	221.52	18.00	15.40	983.36	49
100.00	30,184.06	264.34	168.76	363.94	125.20	178.50		1,100.74	50
5,711.72	37,405.82	582.81	174.97	144.55	330.32		415.23	1,647.88	51
	10,000.00	7,500.00	50.00	200.00	200.00	415.00	750.00	9,115.00	52
	54,253.70	243.90		1,007.12	177.35	195.01	210.69	1,834.07	53
	54,758.13	3,490.65	256.05	765.16	126.86	563.00	204.20	5,405.92	54
	52,969.55	33,777.98	632.98	658.93	1,366.91	1,082.55	931.92	38,451.27	55
320.55	28,652.95	805.23	445.92	1,102.64	534.85	2,251.70		5,140.34	56
393,114.94	3,053,446.90	466,747.93	21,220.48	46,691.71	28,723.56	56,281.63	124,896.62	744,561.93	

^a Including substations.^b For biennium ending December 1, 1910.^c For the fiscal year ended October 31, 1909.^d Including appropriation of \$5,000 from the State Board of Agriculture.^e For the biennium ended March 31, 1909, and including \$20,000 for the Puyallup substation.

TABLE 10.—*Expenditures from United States appropriation of March 2,*

	Station.	Amount of appropriation.	Classified expenditures.						
			Salaries.	Labor.	Publications.	Postage and stationery.	Freight and express.	Heat, light, and water.	Chemical supplies.
1	Alabama ^a	\$15,000.00	\$7,932.86	\$1,361.71	\$1,229.48	\$438.66	\$435.09	\$493.97	\$150.34
2	Arizona	15,000.00	8,352.85	3,177.64	262.56	667.34	370.84	144.25	62.31
3	Arkansas	15,000.00	7,009.42	2,883.39	540.30	565.98	300.84	343.99	166.65
4	California	15,000.00	7,529.50	4,398.22	354.03	605.86	181.90	141.88	400.82
5	Colorado	15,000.00	8,352.74	788.68	2,764.59	693.85	277.48		9.80
6	Connecticut (State)	7,500.00	7,500.00						
7	Connecticut (Storrs)	7,500.00	5,275.87	1,897.68	4.30	24.35			
8	Delaware	15,000.00	7,150.82	3,073.73	735.82	170.70	152.16	282.74	27.74
9	Florida	15,000.00	8,107.18	2,627.10	639.75	471.35	199.51	51.58	55.39
10	Georgia	15,000.00	7,350.00	3,119.52	695.25	282.76	134.46	284.97	
11	Idaho	15,000.00	5,688.55	3,001.41	1,004.25	263.06	396.33	854.19	158.56
12	Illinois	15,000.00	8,268.19	3,026.00	1,833.34	331.08	106.88	120.00	172.63
13	Indiana	15,000.00	9,810.00	1,843.47	882.64	1,242.21	8.00		15.85
14	Iowa	15,000.00	6,866.60	1,830.16	915.25	424.62	87.83	975.89	304.95
15	Kansas	15,000.00	9,002.83	3,152.71	226.35	430.23	171.30	9.26	120.71
16	Kentucky	15,000.00	10,099.16	1,618.53	633.76	358.68	146.31	539.42	83.75
17	Louisiana	15,000.00	15,000.00						
18	Maine	15,000.00	8,647.97	244.74	10.35	367.58	247.99	481.89	77.32
19	Maryland	15,000.00	10,831.63	2,377.56	188.66	150.60	198.99	297.84	15.65
20	Massachusetts	15,000.00	12,734.18	479.84	6.50	103.23	21.48	103.88	91.64
21	Michigan	15,000.00	7,316.61	4,050.80	272.75	264.16	102.78	47.16	354.54
22	Minnesota	15,000.00	8,466.63		1,052.85	87.39		2,548.55	339.73
23	Mississippi	15,000.00	7,745.23	2,868.33	207.00	496.73	95.71	295.26	
24	Missouri	15,000.00	7,041.76	4,373.58	17.30	349.39	1.00	16.97	9.80
25	Montana	15,000.00	7,050.00	3,915.87	1,179.87	592.17	188.86	91.06	189.29
26	Nebraska	15,000.00	10,113.68	198.51	2,116.17	761.51	142.63		124.23
27	Nevada	15,000.00	7,033.02	3,404.58	760.97	374.19	267.67	302.08	78.24
28	New Hampshire ^b	15,000.00	6,875.67	2,602.73	481.97	407.05	285.65	913.50	90.21
29	New Jersey	15,000.00	8,025.00	1,568.13	444.07	901.91	79.39	454.84	221.29
30	New Mexico	15,000.00	6,402.42	2,762.24	925.65	373.99	478.58	202.97	49.49
31	New York (State)	1,500.00	222.53	1,145.33	132.14				
32	New York (Cornell)	13,500.00	7,316.84	901.70	2,202.92	274.85	29.82		28.18
33	North Carolina	15,000.00	7,313.88	2,203.45	662.56	294.12	84.29	39.78	
34	North Dakota	15,000.00	8,421.47	2,920.99	916.26	219.38	65.07	28.36	15.65
35	Ohio	15,000.00	14,898.34			47.88			
36	Oklahoma	15,000.00	6,498.31	4,125.15	1,534.10	697.49	191.53	163.78	82.15
37	Oregon	15,000.00	9,913.83	1,826.46	754.31	185.34	148.53	128.47	148.54
38	Pennsylvania	15,000.00	6,926.52	4,092.86	1,612.29	302.75	162.08		19.15
39	Rhode Island	15,000.00	8,756.73	2,158.42	38.29	286.51	149.19	344.46	59.53
40	South Carolina	15,000.00	7,356.25	1,480.84	1,210.20	173.99	251.32	80.05	455.97
41	South Dakota	15,000.00	6,255.02	2,590.08	1,882.07	302.17	99.05	9.75	365.25
42	Tennessee	15,000.00	8,364.99	2,557.77	1,143.64	323.61	99.36	300.12	139.50
43	Texas	15,000.00	7,878.85	1,700.44	1,730.38	504.18	103.41	30.21	76.28
44	Utah	15,000.00	8,656.85	3,344.03	189.27	379.60	1.45		27.25
45	Vermont	15,000.00	9,241.16	1,949.86	523.58	642.11	70.72	577.24	226.06
46	Virginia	15,000.00	8,779.94	2,686.50	1,609.01	300.04	207.61		161.49
47	Washington	15,000.00	6,977.51	3,345.66	1,094.02	550.41	112.53	1,581.65	4.50
48	West Virginia	15,000.00	10,589.55	820.94	62.46	463.48	284.77		202.04
49	Wisconsin	15,000.00	8,460.00	1,462.70	22.75	204.98	29.84	57.80	467.75
50	Wyoming	15,000.00	6,190.00	1,496.35	912.76	295.11	408.60	705.78	170.27
Total ^c		720,000.00	406,598.94	109,456.39	38,618.79	18,648.63	7,578.83	14,045.59	6,020.49

^a Balance, \$800.^b Balance, \$750.^c Balance, \$1,550.00.

1887, for the agricultural experiment stations for year ended June 30, 1909.

Classified expenditures.										
Seeds, plants, and sundry supplies.	Fertilizers.	Feeding stuffs.	Library.	Tools, implements, and machinery.	Furniture and fixtures.	Scientific apparatus.	Live stock.	Traveling expenses.	Contingent expenses.	Buildings and repairs.
\$546.53	\$356.20		\$523.05	\$39.24	\$169.30	\$212.34		\$89.85	\$21.00	\$200.38
		\$276.95	41.41		205.61	58.26	\$251.87	878.14		249.97
833.38	128.54	400.10	35.34	144.47	970.26	10.00	35.00	489.65	15.00	127.69
357.39	23.25	554.88	1.80	56.69	51.20	98.45		203.80	16.00	24.33
137.54			199.06	3.05	378.71	10.00		669.50	15.00	700.00
6.00				13.86	12.42	16.45		214.07	15.00	20.00
682.13	282.89	356.30	259.99	602.54	11.50		519.93	165.73	55.25	470.03
504.85	363.80	1,164.98	121.60	167.49	71.50	9.00	5.75	313.24	15.00	110.93
417.63	461.22	785.75	9.50	101.08		17.83	533.00	42.03	15.00	750.00
660.17	17.32	265.48	125.58	1,277.24	171.70	101.45	64.05	572.70	15.00	362.96
299.96	11.25		26.99	392.25	102.50	72.30	26.40	195.23	15.00	
298.72			348.35	90.13	280.30	30.36		117.32	16.90	15.75
847.48		1,267.15		288.65		17.80	796.47	5.13		372.02
793.60		5.25		314.16	5.78	115.15	54.00	289.78	15.20	293.69
214.63			774.94	1.20	251.50	6.97	35.00	181.70	15.00	39.45
340.68		1,002.04	523.03	594.11	74.07	134.75	531.45	712.05	259.98	750.00
320.42			195.25	149.23	97.00			90.51	10.10	76.56
362.92	254.53	241.28	143.04		244.00	113.03	10.25	20	15.00	75.00
668.53		23.62	534.92	50.03	107.20	512.93		607.73		86.24
316.33		1,592.61		23.00	97.11	327.60		88.84	15.00	44.36
959.35		1,229.26	35.66	145.62	124.72	2.00	57.50	276.46	30.00	431.17
449.91	4.50	1,949.80	13.95				514.99	242.05	15.00	
386.89	25.00	285.10	171.39	156.65	455.94	19.29	2.00	173.12	15.00	102.50
290.96		742.81		154.75	181.25	71.45		83.50	15.00	3.55
641.29	127.44	487.92	248.45	59.10	26.50	6.00		660.25	37.50	484.80
545.00	122.06	163.27	358.69	85.21	294.99	37.98		864.96	15.00	106.06
120.76	411.25	133.75	799.88	182.68	197.53	78.21		269.09	405.00	707.22
355.37	104.00	1,346.28		589.96	189.20		725.00	479.85	15.00	
296.86	10.80	585.77	304.17	9.53	321.25	253.37		257.94	31.00	675.00
565.33	519.57	901.47	23.98	373.65	530.40		464.00	258.52	15.00	750.00
766.11		630.80		375.43	185.83	192.33		179.20	15.00	68.12
38.78									15.00	
436.43	40.95	58.25	245.30	195.70	134.81	16.34	204.10	100.51	15.00	260.10
492.55		980.90		178.82		22.60	101.90	117.75		
363.07	201.71	691.56	72.49	250.36	21.50		15.49	82.28	15.00	170.89
266.46	262.82	795.28	334.12	196.97	562.85	42.00	52.00	356.10	15.00	323.27
696.31	450.18	1,315.93	117.41	232.41	403.70	17.20	58.60	217.76	33.30	448.58
624.12		379.61	169.50	74.55	18.50	871.84	976.46	258.39	15.00	108.64
161.00	180.68	664.10	253.58	114.11	236.24	79.35		129.30	15.00	237.65
275.06	146.35	362.91	64.73	197.50	53.70		612.50	448.50	65.00	750.00
344.22	37.50	652.23	20.13	81.57	9.40	24.40	769.30	330.18		132.62
166.12	215.46	2.80	156.63	82.11	283.63	135.11		516.89	15.00	195.52
259.55	28.42	7.99	174.97	68.55	235.50	56.90	8.67	379.86	35.00	
74.33		59.49		7.40	76.09	275.95		825.46	15.00	
91.28	37.60	342.01	156.65		173.61	6.30	435.00	937.06		397.25
364.66	41.21	831.53	464.63	678.24	161.00	341.62	564.00	542.60	15.00	289.69
448.49		2,082.60	35.71	485.95	159.51	196.75	388.00	866.41	15.00	142.71
19,089.15	4,866.50	25,619.81	8,085.87	9,285.24	8,339.31	4,611.66	8,812.68	15,781.19	1,436.23	11,554.70

TABLE 11.—Expenditures from United States appropriation of March 16,

	Station.	Amount of appropriation.	Classified expenditures.						Seeds, plants, and sundry supplies.
			Salaries.	Labor.	Postage and stationery.	Freight and express.	Heat, light, and water.	Chemical supplies.	
1	Alabama.....	\$11,000.00	\$7,059.88	\$542.58	\$30.24	\$98.38	\$99.34	\$201.20	\$435.54
2	Arizona.....	11,000.00	10,072.65	123.38	17.27	100.80	.....	147.49	37.23
3	Arkansas.....	11,000.00	7,387.29	638.86	20.42	54.25	126.63	365.63	271.86
4	California.....	11,000.00	5,376.32	1,391.57	33.01	96.21	66.85	586.44	692.53
5	Colorado.....	11,000.00	8,005.54	5.25	52.37	42.25	.....	1,043.85	48.06
6	Connecticut (State).....	5,500.00	2,901.44	1,452.34	22.70	27.76	192.71	399.86	106.97
7	Connecticut (Storrs).....	5,500.00	3,352.92	500.95	24.19	24.91	197.43	261.13	553.20
8	Delaware.....	11,000.00	6,613.51	649.01	123.02	618.74	59.02	530.18	872.17
9	Florida.....	11,000.00	8,051.17	71.17	13.02	150.14	45.40	913.92	329.22
10	Georgia.....	11,000.00	5,887.50	1,122.08	90.37	138.12	151.63	109.07	1,006.53
11	Idaho.....	11,000.00	5,464.75	2,230.42	140.90	134.54	101.73	336.37	1,006.53
12	Illinois.....	11,000.00	7,675.82	1,784.48	.....	31.03	.....	42.31	252.23
13	Indiana.....	11,000.00	8,387.00	571.19	5.76	14.99	.....	111.71	172.03
14	Iowa.....	11,000.00	6,172.83	1,702.58	10.10	1.25	67.37	.....	671.74
15	Kansas.....	11,000.00	4,809.90	2,754.52	77.30	67.45	26.46	.....	498.14
16	Kentucky.....	11,000.00	9,141.68	413.00	.....	.....	.....	150.42	105.20
17	Louisiana.....	11,000.00	8,330.51	1.00	.....	37.41	104.66	226.88	26.65
18	Maine.....	11,000.00	7,659.13	24.60	7.70	10.87	.....	28.26	955.74
19	Maryland.....	11,000.00	7,686.99	252.00	42.12	.....	207.12	325.53	184.61
20	Massachusetts.....	11,000.00	8,163.08	1,004.41	46.75	32.20	230.76	338.80	302.75
21	Michigan.....	11,000.00	6,761.40	338.59	17.08	37.66	.....	466.93	190.70
22	Minnesota.....	11,000.00	8,262.31	1,340.84	.....	95.95	2.88	9.88	9.78
23	Mississippi.....	11,000.00	3,139.52	1,193.70	19.25	144.21	133.60	108.38	165.27
24	Missouri.....	11,000.00	1,767.51	4,761.37	95.67	.....	39.35	271.51	877.12
25	Montana.....	11,000.00	6,300.00	2,222.41	137.63	119.29	15.70	365.84	314.91
26	Nebraska.....	11,000.00	8,446.23	24.10	12.15	58.03	.....	626.45	471.58
27	Nevada.....	11,000.00	7,074.32	499.45	126.89	410.77	8.60	405.10	523.53
28	New Hampshire.....	11,000.00	7,370.21	1,698.90	19.81	30.42	.....	144.25	220.81
29	New Jersey.....	11,000.00	7,770.00	1,050.47	8.06	28	83.02	413.93	517.02
30	New Mexico.....	11,000.00	6,143.70	1,810.69	47.79	251.22	189.18	127.69	90.16
31	New York.....	1,100.00	1,100.00	.....	.....	.....	.....	.....	.....
32	New York (Cornell).....	9,900.00	7,596.48	539.00	83.23	29.96	.....	189.86	221.11
33	North Carolina.....	11,000.00	8,272.76	1,181.09	.....	.....	.....	409.91	223.34
34	North Dakota.....	11,000.00	7,608.81	1,118.64	.....	56.35	.....	241.17	317.49
35	Ohio.....	11,000.00	8,865.71	1.70	.....	.....	.....	282.04	31.50
36	Oklahoma.....	11,000.00	2,977.10	2,566.11	17.13	136.55	89.37	551.42	325.13
37	Oregon.....	11,000.00	6,174.89	1,874.60	87.96	16.20	41.90	439.06	565.48
38	Pennsylvania.....	11,000.00	6,171.74	1,259.18	51.79	163.98	358.09	621.63	395.87
39	Rhode Island.....	11,000.00	7,572.60	1,455.46	129.69	34.06	255.59	126.43	372.27
40	South Carolina.....	11,000.00	7,175.00	2,284.35	73.56	27.68	.....	22.97	176.49
41	South Dakota.....	11,000.00	5,080.00	4,141.32	8.10	553.48	.....	78.68	229.95
42	Tennessee.....	11,000.00	6,897.75	502.80	16.87	212.29	54.67	232.77	115.56
43	Texas.....	11,000.00	5,358.19	1,703.83	53.80	238.47	104.05	858.66	574.78
44	Utah.....	11,000.00	5,958.02	2,240.48	61.05	3.81	257.73	422.94	244.98
45	Vermont.....	11,000.00	4,962.79	2,418.23	93.72	22.61	120.14	247.84	111.71
46	Virginia.....	11,000.00	8,929.96	595.22	2.88	50.11	.....	233.03	362.95
47	Washington.....	11,000.00	6,747.73	1,518.18	.....	247.35	32.95	242.64	136.22
48	West Virginia.....	11,000.00	6,866.22	1,650.20	100.82	.....	16.53	34.55	55.41
49	Wisconsin.....	11,000.00	6,320.00	1,233.00	.....	.....	16.00	371.80	1,076.55
50	Wyoming.....	11,000.00	7,179.68	408.00	42.85	207.75	111.84	308.48	100.54
Total.....		528,000.00	329,048.54	60,865.60	2,065.47	4,736.48	3,608.30	15,408.69	16,993.53

1906, for the agricultural experiment stations for year ended June 30, 1909.

Classified expenditures.										
Fertilizers.	Feeding stuffs.	Library.	Tools, implements, and machinery.	Furniture and fixtures.	Scientific apparatus.	Live stock.	Traveling expenses.	Contingent expenses.	Buildings and repairs.	Balances.
\$38.40	\$296.21	\$15.02	\$6.35	\$225.50	\$1,132.18	\$60.33	\$89.75		\$269.10	\$400.00
		26.85	64.12		327.86	34.00	26.20		22.15	
	421.81	11.80	23.95	62.25	876.14	158.34	298.91		281.86	
36.70	3.08	5.35	55.30	96.05	419.93	276.85	1,598.96	\$225.00	39.85	
		42.82		414.50	321.49		722.67		301.20	
84.51			7.00		85.50		219.21			
44.26		50.10	71.95	28.96	155.11		24.98		209.91	
142.50	16.97	26.01	153.06		461.91	108.00	70.35	5.55	550.00	
61.83		150.93	31.85	126.48	365.51		626.54		62.82	
94.99	820.01	300.92			1,056.12	103.00	135.66		550.00	
15.00		60.12	458.20				498.05		550.00	
	1,174.26		20.28				19.14			
	150.25	81.00	13.75		157.60	716.64	525.58	5.05	87.45	
	1,931.34		16.24		344.06		84.49			
	221.27	12.30	347.36	140.50	1,020.07	360.68	59.13		175.82	
				13.00	1,176.70					
	16.85	237.54			1,238.94		256.30	4.10	519.16	
8.25		441.77	1.49		889.02	6.90	436.41		529.86	
8.06	651.05	299.74	200.83	112.53	551.92	329.75	33.63		114.18	
260.48		24.85		50.00	513.04		31.26		1.62	
	174.68	15.28	2.48	18.25	1,443.22	883.87	151.66		489.50	
	163.78		44.60	200.00	649.53		46.43		43.00	225.42
	2,840.59	32.58	432.01	538.01	924.23	1,015.00	81.89		231.76	
	2,423.03		4.50		384.00	241.15	103.14		31.65	
		36.46	125.40	5.50	596.01	75.00	516.25		169.60	
	56.50	2.26	120.80	23.10	1,096.29		62.51			
6.00	75.82	97.28	284.00	156.05	614.99		181.05		536.15	
30.75	403.98	100.75	12.94	108.11	228.72	103.40	75.80		451.15	
99.60		64.30	291.85	156.70	79.50		76.22	68.25	315.80	
56.00		14.03	1,490.17	98.00	223.85		6.40		451.12	
		4.57	54.55	504.46	146.63		10.15	25.00	495.00	
		83.40			171.75	389.90			267.85	
4.40	437.82			52.75	695.67	460.80	6.10			
	8.75	477.56	135.58	379.55	736.17		81.44			
	164.57	5.50	44.00	217.69	136.21	3,219.37	144.13		405.72	
14.34	454.17		79.22		22.05	260.50	769.63		200.00	
1,058.85		3.00	27.30	36.00	244.19		287.65		320.73	
35.02	384.12	233.78	64.41	30.42	90.74	90.40	115.01		10.00	
304.16	480.55		64.69		157.47	115.00	31.15		86.93	
18.80	188.22		40.45		99.78	425.00			136.22	
		165.31		259.49	2,445.47		85.42		11.60	
.85	526.61	120.85	373.65	218.30	140.92	302.00	270.90		154.14	
	636.74	215.14	328.91	25.00	59.18		218.15		313.37	
	2,219.17	12.13	43.09	156.00	228.83	178.50	152.98		32.26	
.25			112.69		87.65		292.20		333.06	
	100.98		29.95	49.60	731.17	195.01	444.32		523.90	
	1,260.06	2.70			729.66		283.85			
	1,626.36				161.70		194.59			
	608.03	24.42	19.75	53.80	856.80	494.70	284.67		298.69	
2,423.94	20,937.63	3,498.42	5,698.72	4,556.55	25,275.48	10,618.59	10,730.91	332.95	10,574.78	625.42

TABLE 12.—*Disbursements from the United States Treasury to the States and Territories for agricultural experiment stations under the acts of Congress approved March 2, 1887, and March 16, 1906.*

State or Territory.	Hatch Act.		Adams Act.	
	1888-1908.	1909.	1906-1908.	1909.
Alabama.....	\$314,999.34	\$15,000.00	\$18,019.89	\$11,000.00
Arizona.....	279,803.15	15,000.00	21,000.00	11,000.00
Arkansas.....	313,163.12	15,000.00	21,000.00	11,000.00
California.....	315,000.00	15,000.00	20,926.84	11,000.00
Colorado.....	314,963.24	15,000.00	20,756.22	11,000.00
Connecticut.....	315,000.00	15,000.00	21,000.00	11,000.00
Dakota (Territory).....	56,250.00			
Delaware.....	314,382.87	15,000.00	18,050.34	10,999.78
Florida.....	314,966.11	15,000.00	20,996.19	11,000.00
Georgia.....	314,981.55	15,000.00	21,000.00	11,000.00
Idaho.....	240,000.00	15,000.00	19,182.04	9,935.89
Illinois.....	315,000.00	15,000.00	20,864.38	11,000.00
Indiana.....	314,901.19	15,000.00	16,000.00	11,000.00
Iowa.....	315,000.00	15,000.00	21,000.00	11,000.00
Kansas.....	315,000.00	15,000.00	21,000.00	11,000.00
Kentucky.....	314,996.57	15,000.00	21,000.00	11,000.00
Louisiana.....	315,000.00	15,000.00	21,000.00	11,000.00
Maine.....	314,999.62	15,000.00	21,000.00	11,000.00
Maryland.....	314,967.40	15,000.00	20,763.99	11,000.00
Massachusetts.....	314,617.70	15,000.00	21,000.00	11,000.00
Michigan.....	314,676.40	15,000.00	17,341.60	11,000.00
Minnesota.....	315,000.00	15,000.00	20,643.08	10,930.09
Mississippi.....	315,000.00	15,000.00	21,000.00	11,000.00
Missouri.....	310,097.24	15,000.00	21,000.00	11,000.00
Montana.....	225,000.00	15,000.00	18,417.08	10,999.96
Nebraska.....	314,932.16	15,000.00	21,000.00	11,000.00
Nevada.....	314,939.32	15,000.00	20,772.94	11,000.00
New Hampshire.....	315,000.00	15,000.00	21,000.00	11,000.00
New Jersey.....	314,961.97	15,000.00	21,000.00	11,000.00
New Mexico.....	279,998.90	15,000.00	21,000.00	11,000.00
New York.....	314,860.54	15,000.00	20,880.85	11,000.00
North Carolina.....	315,000.00	15,000.00	21,000.00	11,000.00
North Dakota.....	272,330.62	15,000.00	21,000.00	11,000.00
Ohio.....	315,000.00	15,000.00	19,514.02	11,000.00
Oklahoma.....	254,270.80	15,000.00	16,000.00	10,685.69
Oregon.....	301,631.82	15,000.00	16,000.00	11,000.00
Pennsylvania.....	314,967.69	14,999.74	20,995.41	11,000.00
Rhode Island.....	315,000.00	15,000.00	18,464.23	11,000.00
South Carolina.....	314,542.15	15,000.00	19,560.12	11,000.00
South Dakota.....	258,250.00	15,000.00	16,000.00	11,000.00
Tennessee.....	315,000.00	15,000.00	21,000.00	11,000.00
Texas.....	315,000.00	15,000.00	18,876.91	11,000.00
Utah.....	280,000.00	15,000.00	20,821.94	11,000.00
Vermont.....	315,000.00	15,000.00	21,000.00	11,000.00
Virginia.....	314,992.57	15,000.00	20,997.95	10,954.00
Washington.....	255,000.00	14,726.75	17,080.11	11,000.00
West Virginia.....	314,968.71	15,000.00	18,859.12	11,000.00
Wisconsin.....	315,000.00	15,000.00	21,000.00	11,000.00
Wyoming.....	300,000.00	15,000.00	21,000.00	11,000.00
Total.....	14,648,412.45	719,726.49	958,785.22	526,505.41

PROGRESS IN AGRICULTURAL EDUCATION, 1909.

By DICK J. CROSBY,

Specialist in Agricultural Education, Office of Experiment Stations.

SUMMARY FOR THE YEAR.

In many ways the fiscal year ended June 30, 1909, has been one of exceptional progress in the promotion of agricultural education. Many foreign countries have extended their facilities for this work in various ways. This was true particularly in the British Islands and in Canada, where collegiate and secondary courses in agriculture have become available in new localities and much has been done to develop elementary courses and extension work in agriculture.

In this country every bureau and division of the United States Department of Agriculture and nearly every educational institution and association has felt the rapidly growing demand for agricultural instruction. The Weather Bureau, the Forest Service, and the Office of Public Roads have trained more young men for their work; the Bureau of Animal Industry has found it necessary to make more definite provisions for the training of veterinarians for its service; the Bureau of Plant Industry has greatly extended its cooperative educational work, particularly in connection with its farm demonstration work in the South; and the Office of Experiment Stations has broadened the scope of its agricultural education service so as better to meet the demands made upon it by all sorts of educational institutions for advice and assistance in developing agricultural instruction. The session of the Graduate School of Agriculture, held under the auspices of the Association of American Agricultural Colleges and Experiment Stations at Cornell University, brought together more investigators and advanced students in agriculture, and was more generally successful than any previous session.

The agricultural colleges have added greatly to their equipment, increased their teaching force, enrolled more students in agriculture than ever before, established new extension departments, organized departments of agricultural education, held summer schools and longer courses for teachers of agriculture, and published considerable literature for the use of teachers and pupils in public schools.

In the field of secondary education, special agricultural schools have been started or provided for in Arkansas, Idaho, Maryland, and

Oklahoma; state aid for agriculture in public high schools has been granted in Alabama, Louisiana, and Minnesota; and many public high schools have started work in agriculture without state aid.

In the elementary schools the principal development has been made in the organization of boys' and girls' educational contests in growing better corn, potatoes, cotton, and other staple products, and in cooking and sewing. Reports from 395 counties in the United States show that in 1909 more than 150,000 boys and girls were members of clubs engaged in such contests.

EDUCATIONAL WORK OF THE DEPARTMENT OF AGRICULTURE.

The educational work of the Department has been extended in several directions. As heretofore the Office of Experiment Stations has represented the Department in its relations with educational institutions, but the other bureaus and divisions have also done more than in former years to extend the general development of facilities for instruction in agriculture.

The Weather Bureau, at the request of the Mexican Government, admitted four young men to its laboratories for instruction and practice in meteorology and Weather Bureau methods. It also maintained a school of instruction to prepare young men for the position of assistant observer in this country. Concerning this school the Chief of the Weather Bureau reports as follows:

The work of instructing assistant observers at the central office was begun the first of November with a class of 10 young men, all of whom had passed the required civil-service examination and received probationary appointments.

The course of instruction includes the study of station regulations and the weather cipher code; practicing typewriting and telegraphy; taking, recording, and telegraphing observations; preparation of meteorological forms; charting weather conditions as reported twice daily from all stations in the United States and Canada; care of meteorological instruments; and the various other duties performed at stations.

Of this class, one was transferred to another branch of the government service and the others were all qualified for station assignment by the first of April.

A second class of 9 probationary appointees was formed in March. Four are now ready for station assignment and the others will be ready within a few weeks.

Three Mexican students took most of the course of instruction with the first class.

At such times as it could be done without interfering with their regular work, 9 compositors of the Weather Bureau and 1 probationary appointee were instructed in translating cipher reports, casting chalk-plate weather maps, and the necessary knowledge of presswork in connection therewith. These men are now all thoroughly competent to do station printing.

The Bureau of Animal Industry, in connection with its meat-inspection service and the investigation and eradication of animal

diseases, has found it necessary to employ more than 800 veterinarians. The need of securing men well educated for this work led the Secretary of Agriculture in the spring of 1908 to appoint a committee of five eminent veterinarians to investigate the courses of instruction at the various veterinary colleges in the United States and to make recommendations as to the instruction necessary to qualify graduates for admission to the civil-service examination for veterinary positions in the Bureau. This committee consisted of Dr. Richard P. Lyman, secretary of the American Veterinary Medical Association; Dr. Joseph Hughes, president of the Chicago Veterinary College; Dr. Tait Butler, secretary of the Association of Veterinary Faculties and Examining Boards of North America; Dr. Paul Fischer, state veterinarian of Ohio; and Dr. A. M. Farrington, assistant chief of the Bureau of Animal Industry.

After visiting the various veterinary colleges in the United States and one in Canada and collecting full information, the committee made a report with certain recommendations for the classification of the colleges and requirements for admission to the civil-service examinations. Following this report, another committee of members of the bureau's staff, with Doctor Farrington as chairman, was appointed to continue the consideration of the subject and to formulate regulations governing entrance to the civil-service examination for veterinary positions in the Bureau. The latter committee recommended certain regulations, which were approved by the Secretary of Agriculture and the United States Civil Service Commission, under date of July 31, 1909, to take effect September 1.

While the Department claims no authority to regulate the affairs of the veterinary colleges, it is very much concerned in seeing that men are suitably educated for its service, and in conjunction with the Civil Service Commission it has a right to prescribe the requirements for admission to the civil-service examinations for such positions. As a rule the colleges have been disposed to meet the requirements of the regulations, and as a result it is believed that the standard of veterinary education in the United States will be considerably raised. In accordance with these regulations only persons who are graduates of colleges having a satisfactory course of instruction will be permitted to take the civil-service examination.

The regulations recommended by the Bureau committee have been published as Circular 15 of the Bureau of Animal Industry, entitled: "Regulations Governing Entrance to the Veterinary Inspector Examination."

The distribution of vegetable and flower seeds for school-garden purposes has been continued by the Bureau of Plant Industry, which has also begun to cooperate, through its farmers' cooperative demonstration service, with agricultural colleges and schools in the South. On this feature of work the Chief of the Bureau has this to say:

In a number of States a closer cooperation with the agricultural and mechanical colleges has been effected by mutual agreement, to the great advantage of all. Through this arrangement the increasing demand for demonstration work

in connection with schools and colleges has been successfully met. This college cooperative plan also provides for managing the demonstration work among schoolboys. This work among the schoolboys was started in a small way in previous years, and during the past season there have been 12,500 boys enrolled, who have conducted demonstrations in corn and cotton on their fathers' farms. The prizes for this work have been donated by the local people. This boys' demonstration work has proved of great value.

The Forester, in his report for 1909, refers to the growing educational work of the Forest Service in the following paragraph:

In its cooperation with teachers and others connected with educational work the Forest Service markedly enlarged its activity. A widespread desire now exists among teachers and officers of public instruction to utilize in school courses, usually in connection with nature study, geography, or agricultural education, some of the material of forestry and information concerning our forest resources. This opens an exceedingly valuable avenue for diffusing useful knowledge about the best use of forests, but careful preparation of the material is necessary in order to give it a form suited to educational use. In the single State of Iowa, as a result of the work of the Forest Service, forestry was introduced into 114 public schools. Four public schools in the city of Washington cooperated with the Service to devise a good method of utilizing forestry in the graded-school course. Similar work for high schools was carried on in Philadelphia. Courses of study were prepared for other schools. Many teachers and pupils elsewhere volunteered as observers for the collection of phenological data. A circular letter to all school superintendents secured the names of schools in which forestry is now taught. Many photographs and some maps were supplied for school use, and three commercial firms were supplied with prints from which to make lantern slides for the same purpose.

Instruction in highway engineering has been continued by the Office of Public Roads. The Director of that Office describes the work as follows:

Under this project graduate engineers are appointed after a competitive civil-service examination to the position of civil-engineer student at a salary of \$60 per month and field expenses. It is realized that the average graduate from an engineering school does not possess the practical knowledge of road building such as would enable him to take up this work immediately upon graduation. It is therefore the policy of this Office to give the student during a period of one year thorough training in all branches of highway work, both in the field and in the laboratory, during which period his services are fully utilized by the Office in furthering its general work. At the end of this time, if the student has proved his worth to the Office and it is found that the needs of the service justify it, he is retained as a junior highway engineer. At the end of the second year he is eligible for further promotion to the grade of highway engineer, and eventually to the position of senior highway engineer, although no fixed practice has been adopted governing the length of time during which he shall remain in each grade.

The practical instruction and experience which the student obtains in the routine work of the Office is supplemented by a course of theoretical instruction covering a period of eight weeks given during the months of January and February, when field work is at a minimum. This instruction covers the preparation of themes and the study of problems in road construction and in

the testing laboratories, including microscopic work and chemical analysis, a study of dust preventives, platting, field notes, estimates, study and research in road legislation, administration and history, general geology, quarrying, selection of road materials, and special studies of clays, asphalts, bitumens, and cements.

Six engineer students were appointed for service during the last fiscal year, five of whom have remained in the service. This project has given excellent results, and the engineers, after a few years' training with this Office, are in great demand for state and county work. It is a gratifying development that state and county officials are turning more and more to the Office for engineers to carry out their road work. This practice is, of course, injurious in one sense to the efficiency of the Office in that our best men are constantly leaving us, but the result in gain through the distribution of trained men in all sections of the country is so great as to be a vindication of the wisdom of the project.

The investigation with regard to the status of highway engineering in schools and colleges has been supplemented by much cooperative work tending to the improvement of the courses of construction in highway engineering. The Office has aided a number of schools in establishing first-class testing laboratories and has given advice in connection with the course of study.

The Editor of the Department reports a larger volume of business than ever before in the Division of Publications and calls attention to the fact that many requests come from educational institutions where the publications are desired for use as text-books or for reference purposes. He regrets that requests from these sources can not be fully complied with and that applicants are of necessity referred to Senators and Representatives in Congress and to the Superintendent of Documents when large numbers are desired. The attitude of the Department with reference to the use of its publications by educators and schools is clearly set forth in the following paragraph from the report of the Secretary of Agriculture for 1909:

The Department recognizes the fact that teachers and pupils in the public schools are most effective agencies in the rapid and widespread dissemination of information and that the sending of suitable agricultural literature to the public-school teachers who request it is likely to be productive of great good. And while it is true that many of the department publications are suitable in their present form for use in public schools and many thousands of them annually go into the schools, it is also true that much needs to be done in the way of preparing agricultural literature and compiling information with special reference to the needs and limitations of pupils in the public schools. This function the Department has begun to exercise and purposes to develop more fully in future.

During the year 1909 there were issued 1,200 separate publications, of which 715 were new or recently revised publications and 485 were reissues of earlier publications. These publications contained a total of 42,263 printed pages and a total of 17,190,345 copies of them were printed.

EDUCATIONAL WORK OF THE OFFICE OF EXPERIMENT STATIONS.

The Office of Experiment Stations continued to act as the general agency of the Department to deal with the various colleges, schools, and extension departments in the United States, concerning matters relating to the promotion of agricultural education. This educational work was carried on under the same general arrangement as in the preceding year, one section dealing with agricultural colleges and schools and the other with farmers' institutes and other forms of agricultural extension work. An addition of \$5,000 to the appropriation for this work permitted some new developments, but the delays incident to securing additional assistants for the work made it nearly the end of the year before full advantage could be taken of the increased funds.

The agricultural education service relating to colleges and schools was continued under four general classes: (1) The collection and publication of information regarding the progress of agricultural education at home and abroad; (2) studies of different grades of American and foreign schools in which agriculture is taught; (3) cooperation with the Association of American Agricultural Colleges and Experiment Stations, and other important educational associations; and (4) aiding agricultural colleges and schools and state and local school authorities along lines of agricultural education.

In this service the specialist in agricultural education was assisted during July by Mr. H. O. Sampson, who spent that month teaching agriculture in the summer school for teachers at Cape May, N. J., and then resigned. The vacancy thus caused was filled late in February, 1909, by the appointment of Mr. F. W. Howe, of the Michigan Agricultural College, as assistant in agricultural education. Mr. Howe's preparation for the educational work of the Office was acquired not only through the study of agriculture, but also through long experience as a student of pedagogy and teacher and administrative officer in different types of schools and colleges. He has assisted in the general work of the agricultural education service, lectured at a number of summer schools and conferences, and organized boys' corn clubs in Michigan with a total membership of about 1,700 members.

RELATION TO AMERICAN INSTITUTIONS.

(1) The department of agricultural education in the Experiment Station Record has contained numerous abstracts and notes and occasional editorials relating to this subject. The preparation of these involved the examination regularly of many educational journals and other publications, both American and foreign. Annual statistics of agricultural colleges and experiment stations in the United

States, a list of institutions in the United States offering courses in agriculture, and a card index of agricultural institutions have also been prepared. A circular has also been published on The American System of Agricultural Education and a bulletin entitled School Gardening and Nature Study in English Rural Schools and in London. A review of progress in agricultural education in 1908 was submitted for publication, as were also a circular on Education for Country Life and a bulletin on Secondary Agricultural Education in Alabama.

(2) Studies of American and foreign schools in which agriculture is taught have been carried on in connection with the editorial and other work of the Office, and the number of cards in the index to these institutions has been increased by 625, making a total of 5,800 such cards. The number of cards of foreign agricultural research institutions is now 1,390. In connection with the annual inspection of agricultural experiment stations and on occasions when members of the staff have been called upon to attend important meetings in the different States, the work of American colleges and schools of agriculture and of normal schools offering courses in agriculture has been studied. A special study of methods and equipment used in teaching agriculture in the land-grant schools for negroes in Alabama, Florida, Louisiana, Mississippi, North Carolina, South Carolina, and Tennessee was made for this Office by J. O. Rankin, professor of agriculture in Talladega College, Talladega, Ala.

(3) The educational work in cooperation with the Association of American Agricultural Colleges and Experiment Stations has been carried on as formerly. The Director of this Office has continued to act as bibliographer of the association and as chairman of the committee of the association on instruction in agriculture, which submitted at the convention of the association in 1908 a course in agricultural engineering, and is now engaged in studying courses in home economics, animal husbandry for public schools, and courses in agriculture in state normal schools. These courses have been prepared by specialists employed by this Office or by the committee. The Director also acted as chairman of a committee of the association on the history of agricultural education and as dean of the third session of the Graduate School of Agriculture, held during July, 1908, at Cornell University (pp. 280-287). He has accepted the deanship of the fourth session of this school, to be held at Ames, Iowa, in 1910.

The specialist in agricultural education has continued to act as secretary of the committee on instruction in agriculture of the Association of American Agricultural Colleges and Experiment Stations, and in this capacity has directed the preparation of the manuscript courses in animal husbandry and normal school agriculture mentioned above.

(4) The facilities of the Office for aiding agricultural colleges and schools and state and local school authorities along lines of agricultural education have been improved and the demands upon the Office for work of this character have been greater than ever before. The perfecting of card indexes of agricultural colleges and schools and agricultural research institutions has facilitated the compilation of data frequently called for by correspondents concerning courses of study, appropriations, equipment, and foreign institutions.

The card directory of teachers and investigators in agriculture has been revised and extended until it now includes about 1,800 names.

Requests for assistance in outlining and organizing agricultural courses and for other information of this character are steadily increasing in number. About 3,000 such requests were attended to during the past year and in many cases the replies involved the compilation of considerable data not available in published form. Requests for public addresses, conferences, and other services involving travel by members of the Office staff have been far in excess of the ability to grant. The specialist in agricultural education was in the field on such work over three and one-half months and his assistants two months.

RELATION TO FOREIGN INSTITUTIONS.

BRITISH ISLANDS.

A report of considerable importance concerning agricultural education in England and Wales was submitted in 1908 by a special committee appointed by the president of the board of agriculture and fisheries. The report comprises a brief history of agricultural education in England and Wales up to the present time, a more extended view of the progress and development of agricultural education from 1888 to 1908, a description of existing facilities for agricultural education, and recommendations concerning its further development. The inquiry of the committee did not extend to rural secondary and elementary schools, since these are under the control of the board of education and are not within the province of the board of agriculture and fisheries.

It seems that England and Wales have two main sources of financial support for technical and agricultural education. The first includes funds derived from the excise act of 1890, which are turned over to local boards known as county councils to be used for the encouragement of agricultural education, experiments, and demonstrations. These funds are largely used in the counties from which they are derived or are devoted to the support of educational centers which serve two or more counties. These centers may be universities, agricultural colleges, or special institutions deriving their main support from these funds, or they may be special institutions estab-

lished and maintained by the county councils. The second source includes funds controlled by the board of agriculture and fisheries, which are used for the encouragement of agricultural education by making grants to a selected list of institutions giving instruction in agriculture. In several instances the institutions aided by the board of agriculture and fisheries also derive a part of their support from county councils.

The committee in its investigations made a study of the work of six universities and university colleges, five agricultural colleges, two dairy institutes, one fruit and cider institute, one veterinary college, and four agricultural or farm institutes, all of which receive grants from the board. The committee also sought information from every county council concerning its provisions for technical and practical instruction in agriculture, from nine colleges and institutions which give instruction in agriculture but are not aided by the board, from two technical colleges for women, and from many agricultural societies, landowners, farmers, farm managers, and others who might have opinions of value concerning the subject of their inquiry. In this way a large mass of information was collected, which has been published in Part II of the committee's report, Part I being devoted to its findings and recommendations. The committee also made a considerable study of facilities and methods of teaching agriculture in other countries with a view of recommending such features of instruction as would be applicable to conditions in England and Wales.

In general the committee found that satisfactory progress had been made in practical and scientific instruction in agriculture during the past twenty years, and that farmers now take a keen interest in the work of agricultural institutions. It believes that the establishment of a few more higher agricultural institutions, some of which are now projected, would furnish the country with a sufficient number of collegiate centers; but it found that "the facilities for agricultural instruction of a lower grade are unorganized, unsystematic, and wholly inadequate."

The committee is evidently convinced of the importance of providing a thoroughly equipped staff of specialists for the higher institutions, and well-trained teachers for those of lower grade. With reference to the development of existing facilities the report states that "attention should be given to securing a highly qualified staff. Many institutions employ too few teachers or relegate the teaching of important subjects to junior members of the staff. It is of special importance that higher qualifications should be secured in the teachers of such subjects as agriculture, agricultural chemistry, and agricultural botany. * * * Further developments in agricultural education will be difficult until a greater supply of well-qualified

teachers is available." The committee also recommends the employment of itinerant instructors in agriculture, horticulture, farm hygiene, dairying, poultry keeping, and other subjects in every county, and emphasizes the fact that these instructors should be selected from those who have had practical experience. They should have their headquarters at a centrally located agricultural institution, so that arrangements for systematic demonstrations or improved practice can be made. And finally, as regards the teaching force, it recommends "that universities and colleges in receipt of aid from the board of agriculture should provide courses of instruction on subjects bearing on agriculture and horticulture for elementary school teachers."

Lack of attention to post-graduate work in agriculture in England and Wales was alluded to by the committee in its recommendation that "the board of agriculture provide or encourage the provision of scholarships for post-graduate research, and also traveling fellowships for teachers, enabling them to study foreign systems of agriculture." It also believes that there should be increased provision for original research, field experiments, fruit stations, and demonstration plats, and recommends that the board of agriculture collate the results of experiments and publish those directly bearing on the improvement of agricultural practice.

As regards instruction in agriculture of a lower grade, which the committee believes to be of vital importance, the winter agricultural school "appears to be especially adapted to the needs of this country." It is believed that within the next ten years from 50 to 60 of these schools will be provided and that their course of study should be especially adapted to boys from seventeen to twenty years old who have already had some practical instruction in agriculture or horticulture. Short winter courses in colleges have been held with success and should be continued, and this is true also of local winter courses, "which should be encouraged until longer and more systematic courses of instruction are available at winter agricultural schools."

The committee calls attention to satisfactory instruction now being given in a number of special subjects, such as forestry, dairying, and veterinary science, and recommends that greater attention be given to such instruction in future.

With regard to the organization of agricultural instruction the committee believes that—

agricultural instruction, when provided by universities, university colleges, agricultural colleges, farm institutes, and winter schools, or by means of special classes or courses of lectures in agriculture and kindred subjects (e. g., dairying, horticulture), should be under the direction of the board of agriculture; while all instruction in agricultural subjects forming part of courses in primary, secondary, or such evening schools as are in definite continuation of the education given in primary schools should be under the board of education.

Credit is given to national agricultural societies for good educational work; but it is stated that local societies have given little aid to either agricultural education or research. Greatly increased funds are needed for agricultural education, and these apparently must come mainly from national sources. The committee believes that the board of agriculture should first aid existing and projected institutions to strengthen their staffs and improve their general equipment and then assist local authorities to make provision for the agricultural work conducted by them.

All members of the committee subscribed to the conclusions and recommendations in this report; but one member, J. C. Medd, believes that certain points of vital importance to the effective organization of a national system of agricultural education have been omitted. One defect in the English system which he considers serious is the lack of intermediate schools of agriculture corresponding to *ecoles pratiques d'agriculture de France* and to some of the agricultural high schools in this country. He believes that no system of instruction is complete which does not provide for the continuous instruction of boys from the age of 14 to 18. Winter schools will not entirely fill this gap, and it can only be filled by the establishment of a few intermediate schools with courses extending over two or three years. He calls attention to the fact that the expense of equipping and conducting such schools is too great for their universal establishment, but believes that they should be established where conditions are favorable and where there is likely to be a demand for them.

Mr. Medd further strongly recommends the holding of conferences of representatives from affiliated or associated counties at their respective university or college centers for the purpose of coordinating and strengthening their work. With reference to the literature published by the board of agriculture and fisheries, he points out that many of the witnesses were unfamiliar with particular reports or leaflets and recommends that all literature issued by the board be distributed free of cost to all agricultural and horticultural colleges and schools, farm institutes, chambers of agriculture, farmers' clubs, and agricultural or horticultural societies.

The report as a whole indicates that the committee has made an exhaustive and careful study of all the facilities available in England and Wales for promoting technical instruction for its youth along agricultural lines, with the single exception of the public elementary schools in rural districts which are under the administration of the board of education. These latter schools are alluded to in Mr. Medd's supplementary statement in a paragraph calling attention to the provisions made by the board of education to train teachers for them in agricultural subjects. The conclusions of the committee show that there is a strong growth of public sentiment in Great Britain in

favor of a complete national system of agricultural education to take the place of the widely varied types of colleges and schools which now afford instruction in agriculture. As an indication of the growth of such sentiment, it is reported by the committee that agriculture now receives recognition in all the universities in that country, and that the Royal Agricultural College at Cirencester, and other agricultural institutions which have hitherto been operated under private control, are considering the advisability of taking, or have already taken, steps to become public institutions.

According to a report issued in 1909 by the board of agriculture and fisheries the total expenditures of this board for agricultural education in England in 1908 was \$58,685, an increase of \$2,668 over the previous year. One of the secretaries of the board pointed out that the facilities for instruction in agriculture in England were far from adequate, and called attention to the remarkable fact that this condition was more pronounced in the agricultural counties than in the manufacturing counties. For example, in four counties in which more than 40 per cent of the whole male population over ten years of age were engaged in agricultural pursuits less than 5 per cent of the excise fund available for education was devoted to agricultural education, while in contrast to these four other counties having less than 7 per cent engaged in agriculture devoted 15 per cent of such funds to agricultural education.

From another source, the Report of the Board of Education for 1906-7, it is learned that considerable progress is being made in the teaching of gardening, fruit culture, and dairy work in the public elementary schools of England. It is stated that gardening is taught in every English county except two, and the number of schools that applied for grants in 1906-7 was over 900 as compared with 371 earning grants in 1903-4. The increase is almost entirely confined to counties in which a horticultural lecturer has been appointed whose duties are to organize and supervise school gardening and to train teachers to teach it. Fruit culture is coming to be one of the important features of school gardening, and bee keeping is sometimes associated with it. Dairying has been reintroduced into the code as a special subject for which grants may be given and is looked upon as a subject especially valuable for girls, not only as an important branch of domestic work, but also as a means of education and as a practical means of giving instruction in the principles of hygiene.

Studley College, Warwickshire, England, has added to its curriculum a housewife's course, which may be taken either separately or in conjunction with dairying and poultry keeping, which go to make up the "colonial training course." The instruction leads to a certificate and will include training during three terms in cooking, laundering, and housework, together with lectures on sick nursing,

first aid, theory of education, and household management. At Arlesey College, Bedfordshire, a home and colonial training course for women was opened in 1908. The full course of training extends over two years, and includes housework in all its branches, the care of bees, pigs, and poultry, and simple gardening. During the first six months of the course students do the cooking the first week, the housework the second, and the third they go into the garden. Then they can go outside and specialize or work in the house entirely. Not more than 8 students, between the ages of 18 and 30, are received for training at one time.

The University of Manchester has established a three-year course in agriculture leading to a degree in science.

In Scotland a lecturer on agriculture and rural economy has been appointed in the United College of St. Salvator and St. Leonard, of St. Andrews University, the oldest university in Scotland. A course of 50 lectures on the principles of agriculture was offered in 1908-9, and this course was arranged to meet the requirements of candidates for the national diploma in agriculture, including illustrated lectures supplemented by demonstrations in the field, practical work in the laboratory, and excursions to some of the best farms in the neighborhood.

An encyclopedia of agriculture, published in Edinburgh in 1908, contains a rather full and interesting discussion of agricultural education in the British Islands, beginning with the first attempt to institute systematic instruction in the theory and science of agriculture in 1790, when a chair of agriculture was established in the University of Edinburgh. In Ireland the first state-supported school of agriculture was established in 1838, and in England the first agricultural college was founded at Cirencester in 1845. The development and present status of agricultural education in England, Ireland, and Scotland, and the part taken by state and local governments in this educational work are described.

In Ireland the promotion of agricultural instruction was continued under the auspices of the department of agriculture and technical instruction and much attention was given not only to instruction in the Royal College of Science, Dublin; Albert Agricultural College, Glasnevin, and other agricultural stations and institutions, but also to special instruction for the preparation of teachers, and to itinerant instruction in all parts of the island.

CANADA.

In nearly all of the Canadian provinces there has been great activity in promoting the different phases of agricultural education. This was particularly true of the development of courses for the train-

ing of teachers of agriculture and home economics at Macdonald College, Ste. Anne de Bellevue; at the Ontario Agricultural College, Guelph; and at the Manitoba Agricultural College, Winnipeg. The law of Manitoba now requires that every teacher in the Province taking normal work shall take the teachers' course at the agricultural college before receiving a certificate. The work includes field husbandry—importance of field crops in western Canada, insect economy, grain judging, and identifying foul weed seeds; animal husbandry—lectures on the relation of live stock to modern agriculture, principles of feeding, development, and characteristics of the more important breeds of live stock, together with practical demonstrations in the judging pavilion; dairying—milk testing, composition of milk, and its products, principles of cream separation, churning, and related questions; horticulture, forestry, and botany; and some work in mechanics.

Teachers' courses are also offered at the Nova Scotia Agricultural College, Truro, with an instruction staff drawn from the agricultural college and the normal school. The course is arranged so that the work can be completed in three summer vacations, or if students have had considerable science training, in less time. Following the lead of the Ontario education department, Nova Scotia gives teachers completing this course and receiving a rural science diploma an extra grant of money.

Quebec reports rapid progress in the introduction of horticulture into the primary schools of that Province. In 1906 there were 425 students in elementary horticulture, and in 1907 the number increased to 1,258. The agricultural school at Oka is being converted into an agricultural institute to be affiliated with Laval University, and the government has considerably increased the grant to this school to enable it to raise its teaching to a higher plane.

The Ontario Agricultural College, at Guelph, has erected a number of new buildings, including a farm mechanics building. Prof. S. B. McCready, of that college, has published an outline of a two-year course in agriculture suitable for high schools and collegiate institutions. It includes suggestions for instruction in agriculture, physics, chemistry, botany, horticulture, agronomy, animal husbandry, dairy husbandry, poultry keeping, farm carpentry, and farm economics, items of equipment needed and their cost, and regulations to govern agricultural departments in high schools and collegiate institutes.

A college of agriculture has been established in connection with the University of Saskatchewan, at Saskatoon, with W. J. Rutherford, formerly deputy commissioner of agriculture of the Province of Saskatchewan, as dean of the college. The college is to include departments of animal husbandry and veterinary science; field husbandry and soils; farm mechanics, including carpentry, blacksmith-

ing, and farm machinery; dairying; horticulture and tree planting; nature study, including biology and geology; chemistry; physics; mathematics; and English. There will also be an extension department, which will take over the work now carried on by the agricultural societies, under the direction of the superintendent of fairs and institutes.

A department of forestry has been established in the University of New Brunswick, at Fredericton, with a four-year course leading to a bachelor's degree.

GERMANY.

A new horticultural winter school has been opened at Elmshorn, under the direction of Dr. Ludwig Rabe. The school was founded by the Association of Commercial Horticulturists of Germany, and receives additional aid from the state, the District Pomological Society of Pinneberg, and the Chamber of Agriculture of Schleswig-Holstein. It is the first elementary horticultural school to be devoted especially to commercial horticulture. The course will extend through two winter terms, from December 1 to March 1, the first year's work including soils, drawing, surveying, horticultural plant production with special attention to the nursery industry and pomology, forestry, and chemistry in its relation to fertilizers and plant production, while the second year includes in addition fertilizers, bookkeeping, and plant diseases.

The first trade high school for southern Germany was opened in Mannheim, on May 1, 1908. It is under the direction of the minister of justice and public instruction of the Duchy of Baden, and has for its object the provision of instruction in political economy, sociology, and agricultural science as they are related to trade and manufacturing industries. The course consists of four semesters of six months each, the hours of instruction being mostly in the evening, as the school is intended to provide an education for those who can not devote their whole time thereto. The subjects taught are as follows: (1) Production and trade—hunting, hunting laws, and fur trade, inland and sea fisheries and trade in fishery products, forestry and lumber trade, stock raising, meat, dairy products, trade in stock, wool, hides, leather, farm and grain production, grain trade, agricultural by-products and distilling, plantations and sugar and cotton trade; (2) mining and metal industries; (3) international economy and colonial politics; (4) banks and banking; (5) science of finance; (6) life insurance; (7) protection of laborers. Special lectures will be given on state and private railway systems, the economic workings of railways and railway traffic, fundamental principles of political economy, securities, exchange and settlement of accounts, and similar topics.

Germany, following the lead of Italy, began giving instruction in agriculture to subalterns and privates in the German army at Augsburg in 1907, and by 1909 was giving such instruction in 14 other places. The courses extend over twenty days and include instruction on the origin, formation, and management of soils, the composition and use of manures and fertilizers, plant life, farm crops, diseases and insect pests of plants, grasses and forage crops, care of the orchard, animal husbandry and nutrition, milk and its utilization, farm management, and farm accounts. There are now upward of 3,000 students taking these courses.

OTHER EUROPEAN COUNTRIES.

Austria is well provided with agricultural and forestry schools. In 1906-7 there were 195 such schools, including 3 high-school institutes, 3 agricultural academies, 9 agricultural high schools, 5 forestry high schools, 2 high schools for viticulture, fruit culture, and horticulture, 1 high school for the brewing industry, 43 farm schools or elementary agricultural schools with one-year courses, 75 agricultural winter schools, 10 elementary forestry schools, 17 dairy and housekeeping schools, 23 elementary special schools for horticulture, fruit culture, viticulture, hop culture, alpine farming, and apiculture, 2 brewing and 2 distillery schools. In 1907-8, according to the financial reports, there was a net gain of 5 schools as compared with the previous year. There were 2 less farm schools, but an increase of 5 agricultural winter schools, 1 elementary forestry school, and 1 elementary special school for horticulture, fruit culture, viticulture, hop culture, alpine farming, and apiculture.

The First International Domestic Science Congress was held at Freiburg, Switzerland, September 29 to October 1, 1908. The attendance reached nearly 700, and while the majority of those present were interested in the organization and development of domestic science instruction in city schools, agricultural instruction in the rural domestic science schools was not overlooked, and at the second session it was resolved that domestic science instruction in rural schools should be given an agricultural trend.

In Hungary the state facilities for viticultural instruction included 8 secondary and elementary viticultural schools, 4 communal viticultural schools, the Royal School for Cellar Masters at Budafok, near Budapest, and the Royal Central Viticultural Institute at Budapest, and a staff of 27 viticultural inspectors.

In France, through the efforts of a number of merchants and members of the cotton association of Havre, a practical colonial school has been established which is designed as a training school for artisans and others in the agricultural, industrial, and commercial exploitation of the French colonies.

MEXICO.

The Mexican Herald reports that the results of the first year's work under the new régime in the National School of Agriculture and Veterinary Surgery, at San Jacinto, as well as of the Central Agricultural Station, were very satisfactory. At the school of agriculture the second scholastic year under this management opened with a roster of 460 students, and it was necessary to restrict many applications for scholarships.

NEW ZEALAND.

In New Zealand the government has begun to publish in its official educational journal simple school experiments intended to aid teachers in giving instruction in elementary agriculture. It is recommended that one hour a week be devoted to this work, giving one-third of the time to indoor experiments with plants, one-third to outdoor experiments with plants, and one-third to experiments with soils or milk or other phases of agriculture. Twelve exercises relating to germination are given for indoor work during the first year, and 12 exercises dealing with seedlings for the second year's work. The outdoor experiments are to be conducted in the school garden, and relate to tillage, manures, commercial fertilizers, and the cultivation of particular crops, such as potatoes. Ten experiments with soils are outlined, and 11 with milk. Lists of apparatus and material necessary for these exercises are given. A large number of simple experiments in nature study have also been published on such topics as the composition of air and water, experiments with hydrogen, ammonia, starch and sugar, germinating seeds, roots, stems, leaves, flowers, and fruits.

SOUTH AMERICA.

The Louis Queiros School of Agriculture, located at Piracicaba, State of São Paulo, Brazil, has been reorganized under the directorship of C. D. Smith, formerly director of the Michigan Station. Authority is now concentrated almost entirely in the director, with the general supervision of the secretary of agriculture. The regular course of study is modeled in a general way after that at the Michigan College. It covers three years, with a preparatory year of arithmetic, Portuguese, French, geography, and history, and a subsequent year of special elective work in any of the sciences or in practical agriculture. The three-year course includes three semesters each of botany, chemistry, and biology, and one semester each of stock judging, soils and plantations, harvest and seed selection, veterinary clinics, and carpenter and blacksmith work. The equip-

ment includes a farm of 800 acres of excellent land, large barns, and botanical, chemical, physical, and zoological laboratories. In 1909 the school had \$274,000 for maintenance, in addition to receipts from farm products, amounting to about \$15,000. There were about 10 members in the faculty, and the number of students was increasing so rapidly as to give prospects of shortly reaching the limit that could be accommodated in the school.

Early in 1909 the President of the State of Zulia, in Venezuela, authorized the establishment of the first school of agriculture in that State to be located at Maracaibo.

The Peruvian Government, in accordance with an act passed in September, 1907, established a model poultry farm at the National Agricultural and Veterinary School, Lima, for the purpose of giving instruction in aviculture.

EDUCATIONAL WORK OF THE ASSOCIATION OF AMERICAN AGRICULTURAL COLLEGES AND EXPERIMENT STATIONS.

The twenty-second annual convention of the Association of American Agricultural Colleges and Experiment Stations, was held at Washington, D. C., November 18-20, 1908. The president of the association, J. L. Snyder, in his annual address, discussed "Agriculture and democracy," laying special emphasis upon the relation of agriculture to other productive industries and the dependence of other industries upon agriculture and the function of the agricultural college in promoting democracy. He showed that the growing needs of the future must be supplied by increased production from lands already under cultivation rather than by increase of productive area. With the present rate of increase of population every State in the Union must practically double production within fifty years, and the security of democracy in the contentment of all classes of people depends upon thus increasing production proportionately with increase of population. Provisions for promoting agricultural production are, therefore, direct contributions to the maintenance of democracy, concerning not the farmer alone but every citizen of the Commonwealth. It is consequently incumbent upon the agricultural college and its allied agencies not only to enlarge its own courses in various ways, but also to assume the leadership in promoting improved rural education and better economic conditions in general. For example, inasmuch as production is already outstripping transportation, the improvement of the navigable waterways is of immediate importance; and in this and in the conservation of all the natural resources, the agricultural colleges may take an active part and must train more men for the greater demands of the future.

The executive committee of the association reported conferences with the president of the Carnegie Foundation for the advancement

of teaching, Dr. Henry S. Pritchett, concerning the admission of the land-grant colleges to the benefits of the foundation. At the invitation of the committee, Doctor Pritchett addressed the association, explaining frankly and fully the conditions under which the benefits of the foundation may be secured, and by formal resolution the association expressed its appreciation of the great value to higher education of Mr. Carnegie's act in admitting tax-supported, state-controlled institutions to the benefits of the foundation, and its sense of gratitude for the benefits thus conferred upon American teachers. The resolution also conveyed to the trustees of the foundation and to its president the grateful acknowledgment of the association for their sympathetic and helpful consideration of the land-grant colleges.

The report of the committee on graduate study dealt mainly with the session of the Graduate School of Agriculture held at Cornell University in July, 1908, and emphasized the need of still more general support of this school on the part of the institutions representing the association. It was stated that—

it is evident that the meaning of the school is becoming better appreciated by the colleges of agriculture. While the registration in the three successive schools has regularly increased, and there is every reason to expect this increase to continue, yet it is the judgment of the committee that many of the institutions owe it to the cause of education to take more active and appreciative interest in the Graduate School of Agriculture. This school is setting standards and developing ideals. These standards should be propagated everywhere. They are capable of greatly increasing the effectiveness of education by means of agriculture, and of extending its application. The committee thinks that every land-grant institution must accept the responsibility of furthering this enterprise. Moreover, it is also convinced that no land-grant institution can now expect to do the best work in education unless at least some of its staff actively participate in these graduate schools; and the administration of the institution must also officially recognize the type of work for which the graduate school stands. If for no other reason, the colleges should feel the obligation of cooperating in these schools for the purpose of increasing the supply of available teachers of agriculture. In short, the committee feels that the graduate-school idea is now established, and far beyond the experimental stage. All the land-grant colleges must now recognize it. (See Graduate School of Agriculture, page 280).

Commissioner E. E. Brown, of the United States Bureau of Education, addressed the convention briefly on the importance of enlarging the scope of the activities of the National Government with relation to agricultural education and of more perfect coordination of such instruction with the general work of education. He emphasized the importance of considering agricultural education as an essential part of the general educational system. The desirability of enlarging the work of the Bureau of Education in its relation to the land-grant colleges was urged and the need of a central office for the promotion of various forms of vocational education was pointed out.

A. C. True, of this Office, submitted a brief report for the special committee on history of agriculture, reporting progress in collecting data on this subject and asking the cooperation of the agricultural colleges. The chief feature of his report as bibliographer of the association was a statement made by the Superintendent of Documents, W. L. Post, concerning government documents and their distribution, the lack of permanency as regards designated depositories for such documents, and the desirability of selling these publications instead of giving them away, except to libraries, institutions of learning, and collaborators. Doctor True's report as chairman of the committee on instruction in agriculture consisted of a statement concerning the work of two subcommittees on college courses in domestic economy and agricultural engineering.

The report of the standing committee on extension work made the following recommendations, which were approved by the association:

(1) That each institution represented in this association organize as soon as possible a definite scheme of extension work in agriculture; (2) that the association favor increased appropriations for the United States Department of Agriculture for the purpose of making investigations into all phases of the work of disseminating agricultural information, and of assisting the States in every practicable way to organize the work under the best auspices; (3) we strongly urge that specific authority be granted by the association to this standing committee on extension work to make a study of this subject, and to report on it at a future meeting of the association.

The recommendation that the association organize a section to be known as the section on extension work was indefinitely postponed, but C. F. Curtiss gave notice of a proposed amendment to the constitution, to lie over and be discussed and acted upon at the next convention, permitting the organization of such a section. The recommendations of the committee "that the association place itself on record in favor of a moderate federal appropriation to be made to the land-grant colleges for the purpose of carrying on extension work in agriculture, under a plan which required the States also to make appropriations for the work," and "that the association request Congress to extend the franking privilege to bona fide extension publications issued by the land-grant colleges," were referred to the section on college work and administration for approval, as required by the constitution, but no action was reported by that section at this meeting.

In accordance with a suggestion contained in the report of the chairman of the executive committee and a resolution introduced by K. L. Butterfield, of Massachusetts, the executive committee was instructed to take into consideration the matter of preparing for proper commemoration in 1912 of the fiftieth anniversary of the passage of the first Morrill Act and the fundamental law of the De-

partment of Agriculture and the twenty-fifth anniversary of the passage of the Hatch Act.

In the section on college work and administration, four general topics were considered, viz, Educational Policy, The Value of General Culture in Technical Courses, Administrative Methods, and Military Discipline.

Under the first of these topics, President Andrew Sledd presented a paper on Rural versus Urban Conditions in the Determination of Educational Policy. He held that educational policy should be adapted to the specialized needs of different communities and that its first object should be to raise standards of living on a purely physical basis. In addition to this, the farmer should also be given training that will furnish him poise and contentment. He should be a patriotic, high-thinking man, yet contented with life on the farm. So he must have opportunity, not only for gaining a livelihood, but also for society, recreation, and mental activity. Such opportunity must come largely through a multiplication of educational centers distributed over a State, rather than through one centralized college or university.

President Sledd believes that a moderate degree of specialization should begin early in any school system, but full specialization not till the close of the college course. In the high schools the specialization curve for the student who does not go further should rise sharply until it covers two-thirds of the course, but for the prospective college student it should rise more slowly and cover only about the last third of the high-school course.

Speaking on the value of general culture in technical courses in the land-grant colleges, President G. E. Fellows argued that culture may be obtained from any subject which is so thoroughly taught as to make students efficient. He would introduce into the college course only so much of the so-called cultural studies as will fit graduates to associate with others and present their ideas effectively.

Administrative Methods in American Colleges was the title of a paper by President P. H. Mell, who outlined briefly four forms of college administration: (1) That form in which the whole college community takes part in government but which is applicable only to conditions in Europe, (2) government by trustees, (3) government by faculty, and (4) presidential government. He did not believe that the trustees should enter actively into the details of college administration, but should manage the larger affairs of the college, provide and look after its finances, and fill vacancies, subject to the recommendation of the president. Government by faculty he considered too slow and cumbersome for modern educational institutions and he therefore favored presidential government. The president should be a good business man, but more than a money getter. He

should be a good man, strong intellectually, broad minded, able to appear before men, patient and sympathetic, a ruler of men. The college is a business corporation engaged in educational enterprises and it should have at the head of it a single man of ability, who should represent the trustees on the one hand, the faculty on the other. He should have general supervision over discipline, but should leave the details of it to others.

In the discussion W. E. Stone believed that college teachers should be largely relieved of administrative affairs. M. H. Buckham believed that members of boards of trustees should be impressed with the fact that they have no power except as members of the board, no individual relations to the colleges. W. E. Garrison maintained that the president should be held responsible for results, but that he should have the advice of at least one man on his faculty occupying such a position as dean which would bring him in view of the whole field of college work. W. H. S. Demarest held that the discussion thus far tended to put the board of trustees too far away from the college and that the board should give some cognizance to detail; in fact, should let it be known that on very rare occasions it would consider grievances of students or faculties.

The last topic, Military Discipline in Agricultural Colleges, was discussed informally by Presidents Kerr, Stone, Connell, Nichols, Patterson, Edwards, and Prof. John Hamilton of this Office.

WORK OF THE NATIONAL EDUCATION ASSOCIATION.

The programme of the forty-seventh annual convention of the National Education Association at Denver, July 3 to 9, 1909, was remarkable for the attention given to topics dealing with industrial education in general and agricultural education in particular.

Prior to the formal opening of the convention the National Council of Education considered at length three papers related to these topics, viz, What Industrial Education Means to the Elementary Schools, by A. S. Downing, first assistant commissioner of education in New York; Rural School Supervision, by N. C. Schaeffer, state superintendent of public instruction in Pennsylvania; and The Adjustment of Our School System to the Changed Conditions of the Twentieth Century, by E. G. Cooley, late superintendent of schools in Chicago. Each of these papers dealt in part with agricultural education and was followed by from five to ten three-minute papers and by informal discussions.

At the formal opening of the convention on Monday evening, the annual presidential address by L. D. Harvey dealt with The Need, Scope, and Character of Industrial Education in the Public School System. The principal address at the general session on Wednes-

day afternoon was on Education for the Improvement of Rural Conditions, by J. W. Robertson, president of Macdonald College.

Nearly one-half of all the papers, addresses, and reports presented at the convention dealt in some direct way with one or more phases of industrial education. So decidedly did this subject dominate all others in the papers and discussions of the general sessions and the different department meetings that it shows clearly the almost universal demand for the reorganization of public school curricula along lines giving greater emphasis to local, industrial, and domestic affairs—agriculture, manual arts, and home economics. It could almost be said that the desirability of introducing such work as rapidly as possible into the regular work of the public schools was taken for granted, and that the problems which concerned those who attended the Denver convention related mainly to the methods, administration, and the training of teachers for giving industrial instruction in the schools.

There was also considerable discussion on the purpose and value of industrial teaching. The purpose, it was quite generally agreed, is not so much to uplift agriculture or manufacturing or business as it is to raise the level and increase the efficiency and happiness of those engaged in these pursuits. This was made clear by Doctor Harvey in his presidential address, in which he maintained that industrial education is much more than mere education for skill in industrial processes. "Industrial education," he said, "has for its purpose the acquiring of a body of usable knowledge of greater or less extent related to industrial conditions, processes, organization, and to the administration of industrial affairs, involving the gaining of some skill in the use of such knowledge and the securing of mental, æsthetic, and ethical training through the acquisition and use of the knowledge indicated."

This interpretation of the purpose of industrial education was also adopted by President Robertson, who maintained that the purpose of education in rural schools is not primarily to make a bigger steer or a bigger ear of corn, but to "make a better home for a better child." "The whole idea of education," in his opinion, "is to make the earth an ideal home for the race," and this will not be accomplished by training for culture, the kind of culture popularly defined by the words "leisure, indolence, idleness," but through the refining influence of labor, labor which gives the boy a thrill as he looks upon his work, sees that it is well done, and realizes that he has done it. To realize such an ideal in education, Doctor Robertson believes that we must shift the emphasis from the "three R's"—from letters to training for life in the locality.

Two papers read before the department of secondary education dealt almost entirely with agricultural education. These were: Edu-

cational Unity and Its Preservation while Meeting the Demands for Industrial Training, by Eugene Davenport, of Illinois, and The Ethical Value of the Vocational in Secondary Education, by F. H. Hall, of Illinois. In the department of normal schools H. H. Seerley, chairman of the special committee on agricultural and industrial education, discussed the Davis bill in its relation to normal schools, and in the department of manual training President W. J. Kerr, of the Oregon College, discussed the question of trades school courses as related to agricultural interests. In the department of science instruction, a paper on progress in conservation, by H. A. Winkenwerder, professor of forestry in Colorado College, was devoted largely to an appeal for instruction in forestry in the public schools.

The problem of relating the country schools more closely to the life and needs of the people was discussed at length in the department of rural and agricultural education, especially in a round-table conference, which was attended by Doctor Robertson and other leading educators who have identified themselves with rural school interests. This problem, as stated by D. J. Crosby, leader of this conference, involves both a fuller scheme of education and a new kind of education adapted to the real needs of the farming people. In his opinion—

Such a scheme of public education calls for larger school units, to the end that the per capita cost of education may not be unduly increased when better material equipment, better trained and better paid teachers are provided, and higher grades of instruction are within daily reach of the homes of all rural children. It calls for instruction in the principles and practice of agriculture and home economics in the rural public schools, and for the establishment of a limited number of new special schools of agriculture and home economics. It demands a new point of view in teaching the subjects now generally included in the public school curriculum, to the end that nonessentials shall be eliminated and greater concreteness and effectiveness shall be acquired through problems and illustrations drawn from the farm, the home, and the common things in the natural environment of the children. And, finally, it must have the united support of national, state, and county educational agencies, the bureaus and departments of education, the departments of agriculture, the state universities and colleges of agriculture, the state normal schools, and the various associations of farmers and teachers, to study the pedagogical and practical problems involved in the redirection of country life education. That the problems are vast and complex no one will deny; that they are worth the best efforts of our most profound students of education is equally beyond question of doubt.

It was along these lines mainly that the discussions proceeded throughout the conference, which included short talks on the improvement of the equipment of rural schools, consolidation, the teaching of agriculture, the organization of boys' agricultural clubs, and the training of teachers to meet the new demands made upon them in rural districts. Among those who took part in the conference were

Dr. J. W. Robertson, president of Macdonald College; E. T. Fairchild, of Kansas; J. D. Towar, of Wyoming; and Mrs. Katherine M. Cook, of Colorado.

The other sessions of the department of rural and agricultural education were also well attended, and the discussions on the different papers indicated a lively interest in all matters pertaining to agriculture in public schools. Dr. S. A. Knapp, of this Department, discussed the rural education problem as it appeared to him in the South, and dwelt especially upon the effectiveness of boys' clubs and the need of teaching the young the value and importance of the garden, the poultry flock, and the cow, and how to care for them and realize the most from them. Valuable suggestions concerning the making of a high-school course in agriculture, and the correlation of agriculture with other high-school science, were made by Josiah Main, of the University of Tennessee, and suggestions for the elementary course by R. O. Johnson, of the State Normal School at Chico, Cal. There was also a suggestive paper on Some Means of Awakening and Maintaining Interest in Agricultural and Other Industrial Education, by E. E. Balcomb, of Oklahoma; a comprehensive account of The Present Status of Agricultural Education in the Public Schools, by E. C. Bishop, of Nebraska; and a paper by H. H. Seerley, of Iowa, setting forth the need of national aid in the preparation of teachers of agriculture for the public schools.

A committee appointed last year reported progress in the matter of securing university credits for high-school agriculture to apply on entrance requirements, and at its own request was continued for another year. Another special committee, consisting of E. C. Bishop, Josiah Main, and R. O. Johnson, was appointed to report next year on a suitable high-school course which should include agriculture. The officers elected by this department for the ensuing year were: President, K. L. Butterfield, of Massachusetts; vice-president, C. A. Lory, of Colorado; and secretary, E. E. Balcomb, of Oklahoma.

Another matter which was discussed pro and con at this convention related to the establishment of special agricultural schools, but the various papers were presented at such widely different times and places as to render it difficult to get at the consensus of opinion. The matter was considered first in the department of manual training, where the question of establishing separate trade schools was under discussion, and President Kerr, of the Oregon Agricultural College, argued against separate trade schools for agriculture. Later, in the department of secondary education, Dean Davenport, of the University of Illinois, read a paper in which he presented arguments against the establishment of special agricultural high schools, on the ground that instruction in agriculture should be given in the public high schools, that courses in special schools must of necessity be narrow,

and that the tendency of such schools would be to "peasantize" the farmers as had been done by other agencies in Germany.

There was no opportunity at that time for the discussion of Dean Davenport's paper, but on the following day, in the department of rural and agricultural education, some of his leading arguments were discussed by those who believe in the establishment of a limited number of agricultural high schools to supplement the existing public-school system. Briefly, the considerations advanced were that while there is general agreement that agriculture should be taught in all public high schools attended by rural pupils, there is also a pressing demand and need for a limited number of special agricultural schools for the accommodation of boys who have definitely made up their minds that they want to follow the business of farming; and that while it is true that some of the work in such schools must of necessity be narrower than in the public schools, the instruction in agriculture gains greatly in breadth and thoroughness as well as in the superior laboratory equipment, animals, machinery, and other facilities needed in the teaching of agriculture. There is also abundant opportunity in such schools to provide for short special courses to meet the needs of the boy of limited time and means.

Dean Davenport's arguments that such schools would peasantize farmers was answered by showing that the farmers in Germany, to whom he referred, were peasants long before the establishment of agricultural schools in that country, and that they were peasants not because of the establishment of agricultural schools, but in spite of the uplifting influence of such schools. It was also pointed out that there is a difference between the influence of a school which pupils are compelled to attend and those which they attend from choice. In this country the greatest freedom of choice is given in the selection of courses by pupils attending city schools; there should be similar freedom for the country boy. The influence of the special agricultural school which the country boy may attend or not as he may choose, must inevitably tend toward the uplift of those who profit by its instruction and subsequently engage in the business of farming. It would of course be a most serious mistake to limit secondary instruction in agriculture to schools of this type.

Domestic science instruction was also considered by several departments of the association, as well as by the American Home Economics Association, which met at the same time in Denver. Mrs. E. H. Richards read a paper before the department of elementary education on *The Application of the Household Arts and Sciences to the Work of the Elementary School*, and in the department of manual training discussed the influence of domestic science on rural and city home life. At the latter meeting the influence of domestic arts on rural and city home life was also discussed by Miss Helen Schurz, of Kansas. The

importance of domestic science teaching was further emphasized by L. D. Harvey and J. W. Robertson in their addresses before the general convention, as well as by others who spoke upon the general subject of industrial education.

The American Home Economics Association held three sessions, the first devoted to the discussion of Domestic Science and Art in the High School, Vocational General Training, and College Preparatory; the second to brief addresses on different phases of home economics instruction; and the third to Teachers' Problems in Domestic Art and Science.

A movement which has been under way for a number of years for the reorganization of the departments of the National Education Association culminated at Denver in the adoption of the report of a special committee on reorganization, which reduced the number of departments from 21 to 10. In doing this three departments (physical education, Indian education, and the library) were eliminated entirely. The national council and the departments of higher education, music education, and special education remain as before, while the department of women's organizations becomes the department of school patrons.

The remaining 13 departments will be combined as follows: The department of superintendence and that of school administration into a new department of superintendence; the department of child study and that of normal schools into a department of professional preparation of teachers; the departments of elementary education and kindergarten education into a department of elementary education; the departments of secondary education, business education, and science instruction into a department of secondary education; and the departments of manual training, rural and agricultural education, and technical instruction into a department of industrial education. This last department is also to include domestic science instruction.

AGRICULTURAL EDUCATION AT THE SECOND NATIONAL CORN EXPOSITION.

The growing sentiment in favor of better utilization of all available agencies for promoting agricultural education was strongly emphasized in the prominence given to strictly educational features at the Second National Corn Exposition, held at Omaha, December 9-19, which is enthusiastically declared by an agricultural journal to have been "the most elaborate demonstration of farm products ever held in this country." Nearly 10,000 different exhibits, relating more particularly to the production and utilization of farm crops, and representing 28 States, scattered from Connecticut to Washington, and from Minnesota to Texas, besides entries from Hawaii, Canada, Mexico, England, and Argentina, filled to overflowing the 250,000

square feet of floor space of the large auditorium and the special structures erected for the occasion. The prizes offered in the various contests aggregated in value over \$50,000. It is estimated that the total attendance was 100,000, an average of 10,000 each day.

The magnitude of the exposition was alone such as to bring prominently to public notice the important position of American agriculture, but, as expressed by another farm journal, the exposition "was far more than a mere display of specimens. It was a short course of study." The more popular and spectacular features, together with those more directly for business purposes, were by no means disregarded, but a notable circumstance was the unusual attention devoted to educational phases, thereby making the exposition an educational agency, especially in the realm of farm crops, such as the International Live Stock Exposition has become in the field of animal production.

Although in name this was the second national corn exposition, the first having been held in Chicago in October, 1907, the Omaha show was the first to be developed to so elaborate a degree. Like its predecessor, it was in name an exposition of corn and maize, and its products easily predominated, but the term was broadly interpreted to include other cereals, grasses, an alfalfa palace, special exhibits of the work of the agricultural colleges and experiment stations, a large exhibit of farm machinery, a model kitchen, a students' judging contest, and many other features of interest and value. A complete distillery plant for the production of denatured alcohol was in operation, under the auspices of the Bureau of Chemistry in this Department.

Over half of the entries were in what was known as the junior industrial section. This consisted of exhibits from young people, and included displays of articles made from corn and other grains by the pupils of both rural and city schools, and samples of the corn grown by boys' corn clubs and similar organizations, as well as by individuals. Many of these entries were extremely suggestive as indicative that appeal is being made with success to the farmer of the future as well as of the present.

The educational value of the corn exhibit was much enhanced by an ingenious arrangement through which the racks were so constructed as to make it possible to see every ear entered. Significant, indeed, was the very evident improvement in quality which has been brought about during the past few years. Hundreds of entries of large, well-matured, uniform samples, of rich color and high proportion of kernel to cob, met the eyes in bewildering profusion and rendered extremely difficult the rating of the samples by the judges. In the wheat section there was not only an exhibit of improved types and strains, but the judging of the various samples themselves was also

supplemented by milling and baking tests, thereby acquainting the grower in a practical way with the requirements and point of view of the miller and the consumer.

The object lessons from the exhibits were explained and emphasized anew by a large corps of lecturers and demonstrators. The speakers included men prominent in state and national affairs, a long list of scientists from this Department and the agricultural colleges and experiment stations, and many experts engaged in various commercial phases of the industries. Not infrequently the audience taxed the capacity of the two lecture halls which were available. A special feature was a two-day session of the Commission on Country Life, in which farmers, agricultural editors, professional and business men, and many others participated.

The third day of the exposition was set aside by the management as Agricultural College Day, and special trains brought several hundreds of students from the near-by States for the occasion. But to a large degree the name might well have been applied to each and every day of the exposition, so prominent was the influence of these institutions, and so apparent the confidence and esteem with which their work was regarded. In the main auditorium a prominent section was reserved for their special exhibits, 12 institutions presenting illustrative material with reference to their work both in general and with particular reference to those phases relating to crop improvement. Thus, Illinois showed that the protein content of corn could be increased by selection; Ohio, that wheat must be improved by selection, and not by the fanning mill; Indiana compared the results of continuous cropping with rotation in wheat growing; and Wisconsin showed how, through the State Experiment Association, improved seed has been distributed in the State. The Iowa and Nebraska exhibits were especially elaborate, the former giving prominence to cultural methods, and the latter to feeding problems and cereal diseases and insect pests.

A novel and instructive feature for women was what was known as the "model kitchen." This was in reality a school of domestic science, and was under the management of the head of the domestic science department of the Iowa College, assisted by teachers of home economics from the Illinois and Missouri universities and elsewhere. Here a ten-day course was given to a class of young women numbering 60, with daily demonstrations and lectures which were open to the general public.

For the farmers and experts in embryo—the students in the agricultural colleges—a special incentive was offered in the form of a judging contest. In this, teams from the Iowa and Kansas colleges and the Missouri University struggled in a keen but good-natured competition, finally won by the Iowa College, for the possession of

prizes, aggregating several thousand dollars in value. Among these were the grand sweepstakes trophy—a silver cup valued at \$1,500 and presented under the auspices of the Mexican Government to stimulate interest in corn judging—and a thousand-dollar trophy offered by the Western Grain Dealers' Association for the judging of oats. The contests involved the grading of selected and commercial samples of the different grains, and also a statement of the reasons for the judgments made; and there were public lectures by representatives of boards of trade and grain exchanges as to the methods of grading, buying, and selling. Thus the opportunities open to the students were much extended, and they gained both experience and training of a sort to stimulate and develop subsequent work in the class room.

A national exposition of this sort, if closely held to the educational purpose, presents very considerable possibilities in that field. Like most of the other forms of extension work, it is still in the experimental stage and now possesses the temporary advantage of novelty, which must soon to some extent be lost. Much of the instruction it imparts is admittedly more or less superficial in degree and ephemeral in effect, needing subsequent and continued stimulation through other channels to effect its greatest and most lasting value. As a means of arousing interest, however, of pointing out in a practical way the need of individual improvement, and in revealing the opportunities which scientific effort is developing, it may easily become a factor well worthy of consideration in the work of popularizing the results of agricultural research.

THE GRADUATE SCHOOL OF AGRICULTURE.

The third session of the Graduate School of Agriculture, held at Ithaca and Geneva, N. Y., July 6-31, 1908, continued and in many respects surpassed the notable successes of the sessions of 1902 and 1906. A combination of favorable circumstances, such as an extension of the scope of the school to include additional courses and advanced lines of work, the supplementing of the instruction corps as drawn from the staffs of American agricultural institutions by the securing of a number of lecturers of international reputation, and the increasing realization by agricultural workers, through the practical operations of the Adams Act and other agencies of agricultural progress, of the substantial benefits to be derived from such a school, resulted in a record-breaking enrollment and a session of unusual interest and importance.

The general plan of organization of the school was that followed at the previous session, the Association of American Agricultural Colleges and Experiment Stations, through its standing committee on

graduate study, standing sponsor for the school, and the colleges represented in the association contributing to its support. Following the generous invitation of Cornell University and the New York Agricultural Experiment Station, arrangements were made to hold the school under their auspices. The lectures and seminars were held at the splendid new buildings of the college of agriculture, with a day's excursion to the experiment station at Geneva. To the efforts of the personnel of these institutions and the exceedingly well-adapted facilities which were put at the disposal of the school a large measure of its success should be attributed. Dr. A. C. True, Director of the Office of Experiment Stations, served as dean, as at the previous sessions, and Prof. G. N. Lauman, of the college of agriculture, acted as registrar. At the close of the session resolutions were adopted by the students of the school expressing their appreciation and gratitude to the officers of the school and the institutions represented by them for their many attentions and courtesies.

The total enrollment of students at the close of the school was 164, of whom 15 were registered in the Graduate School of Home Economics, which was in session at the college of agriculture July 13-24, and conducted in close affiliation with the Graduate School of Agriculture. This enrollment was a material increase over the previous sessions, 75 students being registered in 1902 and 131 in 1906. The school was an even more representative body, with students from 37 States and the District of Columbia, in addition to 9 students from Canada, 2 from China, and 4 from India. The character of the school as an institution for advanced study was also clearly apparent, more than two-thirds of the students occupying positions in the agricultural colleges and experiment stations, including at least 40 heads of departments. The membership was further augmented by the instruction corps of 78 to a total of 242. If to this be added the large number of visitors in attendance at the various conferences held during the session, it may be safely estimated that at least 350 persons came into direct association with the school. In the words of Dean True at the closing meeting, "probably never before had there been gathered together for so extended a period so large and enthusiastic a body of scientific men interested in agriculture."

The public opening exercises of the school were held on the evening of July 8 in the auditorium of the college of agriculture, and were largely attended by members of the university community, teachers in attendance at the summer session of the university, and members of the graduate school.

Addresses of welcome were made by President J. G. Schurman on behalf of Cornell University and Director W. H. Jordan on behalf of the New York Agricultural Experiment Station. In the opinion of Director Jordan the third session of the graduate school was

especially important, because the agricultural colleges and experiment stations, having passed through a period when their material equipment and resources were greatly enlarged and strengthened, were beginning to give much greater attention to the character of their personnel. A great demand for better trained men had therefore arisen, and it was the province of the school to encourage and stimulate the more thorough training of agricultural teachers and investigators.

President J. L. Snyder, of the Michigan Agricultural College, as president of the Association of American Agricultural Colleges and Experiment Stations, responded to the address of welcome on behalf of the association and spoke briefly of the relations of the association to the graduate school. He also emphasized the importance of good teaching in the agricultural colleges and the need that the agricultural specialists employed as teachers should study pedagogy and adapt their instruction to the requirements of different grades of students. In a broader way he urged all teachers, whether in school or college, to consider the fundamental importance of agriculture as providing for the general welfare of the people.

Director L. H. Bailey, as chairman of the committee on graduate study, spoke on the character of graduate study in agriculture and the degrees to be given for agricultural courses. He attributed the late development of graduate study to the fact that until recently agricultural knowledge has not been well organized, and there have been no recognized standards for postgraduate work as there have been for undergraduate work. In his opinion, graduate work is the normal and natural work of a university as distinguished from a college, and needs to be definitely recognized as such and to be organized. It should tend to systematize all educational effort and to establish relationships between the different phases of educational work.

In regard to the character of post-graduate work, he placed the first emphasis on its content. It should be personal work and must be pursued largely alone with the minimum of the ordinary teachers' helps. It should be really post graduate in its character and not merely additional undergraduate work, as is often the case. It is now becoming necessary to select the men who are worthy to undertake it, as not every man who has the technical or formal baccalaureate requirements has a post-graduate mind. Most men would better not ask for a master's degree, and only now and then may one apply for a doctorate.

He also said that in the agricultural colleges it is necessary to make the post-graduate work dynamic. One may study so long as to get out of touch with the activities of life, and a result of the general educational systems is to make the students passive; they are not

trained for leadership. Students do not seem to have the power to apply themselves to the problems of life when they go home. The colleges of agriculture are trying to change all this, and it is quite as necessary to carry this spirit through the post-graduate as through the undergraduate work.

With reference to the specific degrees to be conferred, the speaker reaffirmed his belief that simplification is needed and that it is unwise to make separate degrees for agriculture, preferring the earning of the well-established degrees already recognized by the fellowship of educated men. The only degrees in course in his opinion should be the Ph. D., M. S., and B. S. (or M. A. and B. A.)

Dean True, of the graduate school, gave a brief history of the enterprise and summarized some of the causes which are operating to increase the desirability of graduate study in agriculture. He called attention to the large increase in both national and state funds for agricultural education, research, and inspection since the previous session of the graduate school and to the unprecedented demand for trained men to fill positions as teachers and investigators. So short is the supply that much competition for men with successful experience has arisen. Salaries have generally risen—whereas \$1,800 to \$2,000 was considered a good salary for a professor a few years ago, from \$2,500 to \$3,000 is now quite common. The initial salaries of 90 graduates of agricultural colleges in 1907, reported from 33 States, ranged from \$500 (a kind of fellowship) to \$1,700, and averaged \$950. Those of 9 men with master's degrees averaged \$1,200 and of 5 with doctor's degrees \$1,300.

He showed that the White House Conference on the Conservation of our National Resources had brought out the need of a host of agricultural experts to solve the problem of the soil and the crops and to teach the results to the masses of the rural population.

In the opinion of Doctor True—

The paramount need of the time is an adequate supply of thoroughly trained leaders in this cause. It is true we need well-equipped men all along the line. But in the higher realms of research, college and university education, and broad organization for the promotion of agriculture we need a large number of men with much more training than is ordinarily given in the agricultural college. Without these leaders the real advance of our agricultural interests will be slow and halting.

We must develop a class of real agricultural scholars and thinkers—men who will find the satisfaction of their lives in the discovery of new truth and in pointing out the paths of real progress for their fellow-men—men who will stick to their tasks and do good work in higher research and education regardless of commercial inducements or the applause given to more popular leaders. It is to aid in the discovery and encouragement of such men that this graduate school of agriculture has especially been established, and it is hoped that even in the few days devoted to this present session much will be done to this end.

The courses of study offered by the school embraced seven main lines: Biochemistry, agronomy, horticulture, entomology, dairy husbandry and dairying, poultry, and veterinary medicine. The instruction took the form of both lectures and seminars, the programme being so arranged as to afford opportunity for attendance upon a number of these lines, and thereby permitting of extensive correlation of work. Special attention was given throughout to the methods of investigating agricultural problems and teaching agricultural subjects. There were also a number of special sessions which were utilized for conferences on general topics relating to agricultural education.

The faculty numbered 60, in addition to 18 speakers at the special sessions and conferences. It included 19 officers of the United States Department of Agriculture, 25 members of the faculty of Cornell University and 7 members of the staff of the New York Station, and 17 professors and experts from 10 other agricultural colléges and experiment stations, besides the United States Commissioner of Education, a representative of Teachers College of Columbia University, and the New York state commissioner of agriculture and the state entomologist.

In addition, lecture courses and seminars were offered by Dr. C. B. Davenport, of the department of experimental evolution of the Carnegie Institution; Director A. D. Hall, of the Rothamsted Experimental Station; Prof. L. B. Mendel, professor of physiological chemistry in the Sheffield Scientific School of Yale University; and Prof. Dr. N. Züntz, professor of animal physiology in the Royal Agricultural College of Berlin, which attracted particular attention. So great was the interest manifested in these courses that not infrequently the rooms assigned proved inadequate. Doctor Davenport gave 5 lectures and a seminar in the poultry husbandry course, the subjects of the lectures being: Origin of Domestic Fowl, Characteristics of Poultry, General Principles of Heredity, and Application of Principles of Heredity to the Breeding of Poultry (2 lectures). Director Hall had the same number of lectures in the agronomy course, his lectures taking up Special Effect of Fertilizers upon the Character and Composition of the Crop, Special Effect of Fertilizers upon the Reaction and Texture of the Soil, and General Discussion of the Theory of Fertilizers in Relation to the Soil and the Plant.

Unusual interest centered around the course in biochemistry. This course was offered for the first time and proved exceedingly popular and profitable, and may be summarized as an example of the advanced grade of work offered by the school. Following an introductory lecture by Dr. C. F. Langworthy, of this Office, on Physiological Chemistry in Relation to Animal Nutrition, the remaining four lectures of the first week were given by Dr. A. L. Winton, of

the Bureau of Chemistry of this Department, who took up the Microscopical Methods for Detecting Adulteration in Feeding Stuffs. Doctor Winton outlined the technique of such microscopical work and discussed methods, showing in detail how it is possible to identify adulterants by differences in their structure as shown by the microscope in comparison with the standard food materials. In the weekly seminar opportunity was given for demonstrating in greater detail his methods and their application.

Doctor Mendel gave five lectures and two seminars during the following week. The first of the lectures discussed the Chemical Processes of the Alimentary Tract, the second Recent Progress in Chemistry of the Proteins and its Relation to the Problems of Nutrition, and the remaining three Intermediary Metabolism, taking up some aspects of the intermediary metabolism of nucleoproteins and purins and of the carbohydrates and also discussing the biochemical functions and protective mechanisms. The lectures well illustrated the very marked progress in physiological chemistry within the last few years, and directed attention to a very large amount of material which is not readily accessible, but which is of the greatest importance to students of animal and human nutrition. The lectures were also noteworthy in that they demonstrated clearly the possibility of applying physiological methods to the study of practical problems and to both the important relation of many researches along other technical lines to nutrition and the important application of experiment station problems to many investigations in medicine, pathology, and other branches to which the attention of the experiment station worker might not ordinarily be directed.

Director Armsby gave the five lectures of the third week, the main topics being a general survey of the chemical constituents of plants and animals, the physiology of nutrition, feeding stuffs, and feeding.

The fourth week of the course was occupied by Professor Züntz, who gave five lectures and held two seminars. In the lectures Professor Züntz discussed particularly Muscular Action, its Different Forms and its Influences on the Quantity and Quality of Metabolism; The Different Forms of Internal Labor Performed by the Resting Organism and their Influence on Metabolism; the Influence of Internal and External Temperature on Metabolism; and Aims and Methods of Research Regarding the Respiratory Process (2 lectures). These lectures, which were of unusual interest, summarized and discussed the results of his extended researches on metabolism in men and animals, particularly the work with the respiratory quotient carried on by means of the valuable apparatus which he has devised. Professor Züntz brought with him from Berlin the respiratory quotient apparatus, and in the seminars as well as in the lectures demonstrated methods of using it and also special apparatus

for the analyzing of respiration and other gases. His visit also afforded many opportunities of discussing nutrition problems and related topics in a less formal way and was regarded as of the greatest value, not only because of the material presented, but as an inspiration for advanced research in nutrition.

The special sessions devoted to conferences on general topics proved of extreme interest and value, especially to those actually engaged in the work of the colleges and experiment stations. These conferences included addresses as follows: The Pedagogics of Agriculture, Dean T. F. Hunt of the Pennsylvania College and Prof. D. S. Snedden of Teachers College, Columbia University; Defense Work of Agricultural Experiment Stations, Director E. H. Jenkins of the Connecticut State Station and Director W. H. Jordan of the New York State Station; Extension Work in Agriculture, President G. C. Creelman of the Ontario Agricultural College, Prof. John Hamilton of this Office, and Director L. H. Bailey of Cornell University; Editing of Station Publications, Dr. E. W. Allen of this Office and F. H. Hall of the New York State Station; Agriculture in Secondary Schools, Dr. E. E. Brown, United States Commissioner of Education, D. J. Crosby of this Office, and Dr. G. F. Warren of Cornell University; Student Organizations, Director L. H. Bailey and M. G. Kains, assistant editor of *American Agriculturist*; Elementary Instruction in Agriculture, Prof. William Lochhead of Macdonald College, Canada, and D. J. Crosby; and Rural Economy, Prof. H. C. Taylor of the University of Wisconsin, Prof. G. N. Lauman, and Director L. H. Bailey. Considerable informal discussion followed the conferences and added much to their helpfulness.

Well-attended meetings were held during the session of the graduate school by the following organizations: American Society of Agronomy, Association of Dairy Instructors and Investigators, International Conference of Poultry Instructors and Investigators (this resulting in the formation of an association), and the general convention of the Alpha Zeta Fraternity. A number of persons interested in the problems of animal nutrition also had a conference and took preliminary steps toward the organization of an association devoted to this subject. At these meetings subjects covering a wide range were discussed and a large number of the college and station men were brought into brief contact with the graduate school.

The Graduate School of Home Economics held its second session at the college of agriculture, Cornell University, July 13-24, 1908, with representatives from 11 States and Canada. The programme covered a wide range of subjects, and the instruction corps included some of the leading teachers and investigators in home economics and related lines. Practical demonstrations of household appliances were given by the Misses Van Rensselaer and Rose, of the department of

home economics in Cornell University. Special lectures were delivered by Prof. L. B. Mendel, of the Sheffield Scientific School of Yale University, on Foods and Dietary Standards, and by Prof. Dr. N. Züntz, of the Royal Agricultural College of Berlin, on Food Values. The profit and interest of the session were also much enhanced by the lecture of the Graduate School of Agriculture, notably those of Doctors Mendel, Armsby, and Züntz.

The fourth session of the Graduate School of Agriculture has been announced for the summer of 1910 at Ames, Iowa, under the auspices of the State College of Agriculture and Mechanic Arts. The school will, as formerly, be under the general management of the Association of American Agricultural Colleges and Experiment Stations through its committee on graduate study, of which Dr. H. P. Armsby is chairman. Dr. A. C. True, of this Office, has again agreed to serve as dean.

THE AGRICULTURAL COLLEGES.

In 1909 agricultural colleges receiving federal funds were in operation in all the States and Territories except Alaska. Including the separate colleges for negroes in the Southern States, there were 67 such institutions. There was also established a college of agriculture in the Philippines, in accordance with the provisions of act 1870 of the Philippine legislature of June 18, 1908, which provided for the establishment of the College of Agriculture and the College of Veterinary Science of the University of the Philippines, the latter college to be located at Manila on the site of the animal quarantine station at Pandacan. The college of agriculture was opened at Las Banos with E. B. Copeland as dean and professor of botany. Sixty students enrolled at the opening of the college.

The Rhode Island general assembly changed the name of the Rhode Island College of Agriculture and Mechanics Arts to Rhode Island State College, and increased the membership of the board of managers of the college by the addition of the state commissioner of education and a representative to be elected from the state board of agriculture.

In Montana the executive board of the agricultural college has been replaced by a new governing board consisting of the president of the college and two members selected by the state board of education. The powers of the new board are restricted, supervisory control of the finances being vested in the state board of examiners. The change became effective April 15.

Permanent legislation enacted at the last session of the Tennessee legislature has greatly improved the status of the University of Tennessee. It is now fully under the control of the State, and its governing board has been reorganized so that different sections of the State are represented on it. A general education law has been

passed, giving 25 per cent of the state revenues for education, and as stated below, 7 per cent of this amount will go to the university. The law also provides that high schools and normal schools must teach agriculture in order to receive state aid, and this provision has led the university to make plans for aiding these schools along agricultural lines. (See *The Secondary Schools*, p. 317.)

The agricultural colleges gave instruction in agriculture to more students than in any previous year. The number of white students in four-year agricultural courses was 5,380, a gain of 884 students, or nearly 20 per cent over the attendance in 1908. There were also 9,017 white students in shorter courses in agriculture, and 1,442 negro students in agricultural courses, making a total of 15,839 students enrolled in agricultural courses in the colleges. This is 12 per cent more students in agriculture than ever before enrolled in American colleges.

HISTORICAL DATA.

Considerable progress has been made by the special committee appointed by the Association of American Agricultural Colleges and Experiment Stations to collect data for a history of agricultural education in the United States. The assembling of data has been done through the agricultural education service of this Office and plans are now making to prepare an historical paper to be presented at the proposed celebration in Washington in 1912 of the fiftieth anniversary of the enactment of the land-grant act of 1862 and of the organic act of this Department and the twenty-fifth anniversary of the enactment of the Hatch Act of 1887, establishing state agricultural experiment stations.

Acting for the committee, the Office of Experiment Stations sent out a circular letter dated September 20, 1908, to presidents and other members of agricultural college faculties, directors of agricultural experiment stations, and other educators and investigators who might be familiar with some facts concerning the history of agricultural education in this country, asking them to aid the committee in one or more of the following ways:

(1) By sending to the Office of Experiment Stations pamphlets, reports, letters, and other original documents which can be spared, and which the owner wishes to donate to the historical collection of the United States Department of Agriculture.

(2) By loaning the Office of Experiment Stations similar original documents which the owner does not wish to part with, in order that notes or copies may be made for the committee's use.

(3) By sending the Office of Experiment Stations references to original documents which can not be donated or loaned, so that arrangements may be made to examine the documents.

(4) By furnishing the committee with the names and addresses of men who are familiar with some steps in the early history of the agricultural education movement in this country and who can be consulted by the committee.

As a result of sending out about 750 of these letters, the Office received a considerable number of historical pamphlets or clippings, early prospectuses and catalogues of existing agricultural institutions as well as of some early schools of agriculture which have been discontinued, copies of legislative acts, reports of investigating committees, memorials to legislatures, first editions of text-books, references to historical literature in various libraries, and some manuscripts.

At the request of the committee the specialist in agricultural education of the Office of Experiment Stations visited Dr. W. H. Brewer of New Haven, Conn., and secured from him copies of several early lectures dealing with agricultural associations and containing numerous references to literature concerning these organizations, some notes concerning men who were prominent in the early development of agricultural education in this country, and copies of letters comprising about 100 pages of typewritten manuscript, written in 1894 to Prof. W. T. Hewett of Cornell University, and dealing with the rise of agricultural schools in the State of New York, the men who were prominent in this movement, as well as in the movement for national aid to agricultural education, and incidentally with the origin and purpose of the land-grant act of 1862. This manuscript contains many references to reports, acts of Congress, and acts of state legislatures, which will be of great value to the committee.

Among the papers contributed by Professor Brewer was a copy of the prospectus of Oakwood Institute, which was opened at Lancaster, N. Y., in April, 1851, "for the reception of pupils of the age of 12 years and upward," who "will be carefully instructed in agricultural chemistry, the analysis of soils, etc., by a pupil of Mr. Norton, professor of scientific agriculture in Yale College." The school also announced a course of instruction especially designed for practical farmers and young men from the country, to commence about the 1st of January and continue three months. This apparently was one of the earliest announcements of a short winter course for farmers, but the course was never given. A fire which destroyed the property of two of the chief promoters of the school caused it to be closed just before the short course was announced to begin. Professor Brewer has also contributed a copy of a manuscript prepared by him some time between 1888 and 1892 on "The Intent of the Morrill Land Grant."

A visit was also made to Mr. Bronson Murray, of New York City, who was a farmer in central Illinois from 1843 to 1868 and was closely associated with Prof. J. B. Turner, of Illinois College, Jacksonville, Ill., with whom he became acquainted in 1852, and with him was instrumental in organizing the Industrial League of Illinois, the object of which was to influence legislation to aid instruction

in agriculture and mechanic arts. Mr. Murray, although now 92 years of age, has a remarkably clear memory for early dates and facts in connection with the development of education in Illinois, and his recollections, as related to the representative of the committee, are of considerable interest. He had no way of knowing whether Professor Turner ever met Senator Morrill or influenced him in any way, either by correspondence or otherwise, but he believes that Professor Turner was the first man to agitate and advocate government aid for industrial education in the several States.

Through the kindness of F. W. Howe in preparing a manuscript of 48 typewritten pages, the committee has been able to secure considerable historical data from the earlier reports of the Michigan State Agricultural Society and other publications concerning the agitation for the establishment of the Michigan Agricultural College as well as earlier movements for including instruction in agriculture in the courses of study offered by the Michigan Normal School at Ypsilanti, and the Michigan State University at Ann Arbor.

It appears from this manuscript that as early as 1849 the state legislature in Michigan instructed its "delegation in Congress to use all honorable means to procure a donation of 350,000 acres of land for the establishment of agricultural schools in the State," and Mr. Howe raises the question whether this action does not take priority over any other official action to secure a national land grant for the purposes of agricultural education. It is also shown from a letter written by the state superintendent of public instruction in 1852 to the secretary of the state agricultural society, that the State Normal School at Ypsilanti, which was dedicated October 5, 1852, offered courses of "instruction in the mechanic arts, the arts of husbandry, and in agricultural chemistry," and from a letter written by the chancellor of the state university to the secretary of the state agricultural society, that the university had organized in 1852 "an agricultural school as a part of the scientific course recently adopted by the faculty and regents," in which lectures were to be given during the spring and summer terms (1853) on the following subjects:

- (1) Daily lectures on chemistry (elementary and experimental), chemistry applied to the arts, meteorology and climate.

- (2) Geology and mineralogy, and the application of the same to mining, drainage, construction of public works, etc., illustrated by specimens from Michigan, the neighboring States, and foreign lands; also models and drawings.

- (3) Animal and vegetable anatomy and physiology in general, the physiology and diseases of domestic animals in particular, and, the structure and habits of insects in reference to grain, trees, and horticultural plants.

- (4) Organic chemistry and the theory and practice of agriculture, the origin and nature of the soils, the different varieties of manure, tillage, tools, etc.

The first professor of agriculture in the State University was the Rev. Charles Fox, rector of the Episcopal Church at Grosse Isle, near

Detroit, who had been senior editor of the *Farmer's Companion* and *Horticultural Gazette*, and later, in 1854, published a "Text-book of Agriculture," which was the first agricultural text published west of the State of New York.

Mr. Howe's manuscript goes somewhat into the details of the struggles in Michigan for and against the establishment of the agricultural college separate from the State University; calls attention to the admission of young women students to the college in 1870, who "prepared seed for the ground, cut potatoes, transplanted tomatoes and flowering plants, pruned shrubbery, gathered small fruit, did some work in the greenhouse, and many other kinds of work;" and gives references to records dealing with the early efforts of W. C. Flagg, secretary of the board of trustees of the Illinois Industrial University, and Dr. Manly Miles, professor of agriculture in the Michigan Agricultural College, for the establishment of a society which was the forerunner of the Association of American Agricultural Colleges and Experiment Stations. Ninety-eight pages of the report of the Michigan State Agricultural Society for 1871 are given to the discussions had in the first meeting of this society, held in Chicago, August 24, 1871, which were participated in by such men as Doctor Miles, Professor Swallow, Prof. John Hamilton, now farmers' institute specialist of this Office, Professor Gilman (then of the Sheffield Scientific School, later President of Johns Hopkins University), President Welch, President Denison, Professor Hilgard, and others.

Among other valuable documents received are an article by Paul Selby, of Chicago, on "The Part of Illinois in the National Educational Movement, 1851-1862," and a manuscript contributed by J. N. Hook, of South Carolina, this being a statement dictated by Senator Benjamin R. Tillman, setting forth his connection with the struggle (1885-1890) to establish a separate agricultural and mechanical college at Clemson, S. C.

Interesting historical data on agricultural education are found in a recently published address by M. F. Dickinson on "The Beginnings of College History," which was delivered at the celebration of the fortieth anniversary of the founding of the Massachusetts Agricultural College. This address presented a very interesting review of the movements which led to the establishment of the Massachusetts Agricultural College, the only one of its type in the United States. In 1792 the Massachusetts legislature incorporated the Massachusetts Society for Promoting Agriculture, an organization which still exists and is fulfilling its mission. So far as known only two other agricultural societies have so early an origin—one in Ireland and the other in Scotland; the British board of agriculture was not created until the next year. In 1813 the Massachusetts society began its semi-annual publication of the *Massachusetts Agricultural Journal*, now

superseded by *The New England Farmer*. In 1824 it sought to secure the assistance of the legislature in establishing an agricultural department at Dummer Academy, but the plan failed of support. The death of Benjamin Bussey in 1842 laid the foundation for the establishment of the Bussey Institute of Agriculture, and the death of Oliver Smith in 1845 resulted eventually in the founding of Smith's Agricultural School in 1905. Chiefly through the agency of Marshall P. Wilder the Massachusetts School of Agriculture was incorporated in 1856, but the oncoming of the civil war precluded its practical establishment until the first Morrill Act of 1862 provided for the national system of land-grant colleges. Under this act the state legislature set apart one-third of the annual income for the use of the Institute of Technology as satisfying the requirements for instruction in the mechanic arts, thus leaving the agricultural college at Amherst as the only one now devoted exclusively to agriculture. William S. Clark, who became the third president of the school within two years after its establishment in 1865, is given the chief credit for its location at Amherst.

APPROPRIATIONS.

The state appropriations for the maintenance of agricultural colleges, the construction of buildings, and the purchase of equipment are growing larger year by year. Several of the biennial state appropriations for these institutions have approached or passed the half-million mark, notably in Washington, \$487,256; Pennsylvania, \$526,000, of which \$170,786 is specifically appropriated for the school of agriculture and the station; and Kansas, \$671,500, with over \$12,000 additional to restore endowment. The Kansas appropriation includes \$375,000 for current expenses, \$35,000 for the purchase of land, \$10,000 for a greenhouse, \$52,500 for farmers' institutes, and varying sums for other purposes. There were also many other large biennial appropriations for the colleges, among which may be mentioned \$64,900 for the Arkansas University and Station; \$119,000 for the Colorado College and Station; \$105,000 for the Georgia college; \$165,300 for the Montana College and Station, including \$78,500 for maintenance, \$50,000 for a women's dormitory, \$10,000 for a sheep and steer barn, and \$18,800 for the purchase of land to extend the campus; \$202,100 for the Utah College and Station, which is nearly twice the amount given for the preceding biennium; and \$175,000 for the New York College of Agriculture for one year, which is \$25,000 more than the appropriation for the previous year.

Among the specific appropriations for buildings were \$80,000 to the Florida University and Station for a biological building and a new station building; \$85,000 to the Massachusetts college for the erection of fireproof buildings for the departments of entomology



FIG. 1.—NEW BUILDING OF GEORGIA STATE AGRICULTURAL COLLEGE.



FIG. 2.—AGRICULTURAL BUILDING OF THE MAINE COLLEGE OF AGRICULTURE.

and zoology; \$87,000 to the Oklahoma college, of which \$62,000 is to be used for a domestic science building and girls' dormitory, and \$25,000 for a boys' dormitory; and \$50,000 to the Indiana college for a \$30,000 live-stock judging pavilion, and a \$20,000 farm mechanics building.

The legislature of Tennessee has passed a bill giving 25 per cent of the State's revenue for education. Of this amount 7 per cent will go to the university and experiment station, \$10,000 being set aside for the support of the substation at Jackson, \$5,000 for crop experiments in middle Tennessee, \$7,500 for the station at Knoxville, and the remainder, at present about \$40,000, for instruction at the university. The University of Minnesota has received a gift from the Weyerhaeuser interests of St. Paul of 2,200 acres of land in Carlton County for experimental work in forestry, and Yale University a gift of \$100,000, by Mrs. Morris K. Jessup, to establish the Morris K. Jessup chair of agriculture in the forestry school.

BUILDINGS.

Some of the more liberal appropriations for new buildings have been noted in a previous paragraph. Several important buildings for the accommodation of agricultural work in the land-grant colleges are now in process of construction and several have recently been completed and the more important of them dedicated with appropriate ceremonies. Some of these are described in the following paragraphs.

GEORGIA.

A new home for the Georgia State College of Agriculture has been completed at a cost of about \$100,000, and is now occupied (Pl. IX, fig. 1). The new building is located about half a mile from the present center of the university campus, on Compton Hill, one of the most commanding sites in the vicinity of Athens. From the front of the building an excellent view is obtained of the city, while the rear windows command a general view of the college farm.

The building is plainly but substantially built and is excellently proportioned. It is 264 feet long by 72 to 84 feet wide. There are two stories and a high basement. The foundation and window lintels are of Bedford limestone with terra-cotta trimmings to define the elevations of each story. Cream-colored brick has been used in the construction and harmonizes well with the trimmings. Wide projecting eaves overhang the building, which is surmounted by a red tile roof. A broad flight of granite steps leads up to the main entrance and gives a substantial and imposing appearance to the entire structure. Each story is 16 feet high and the hallways are 10 feet wide, which insures room for the passage of large numbers

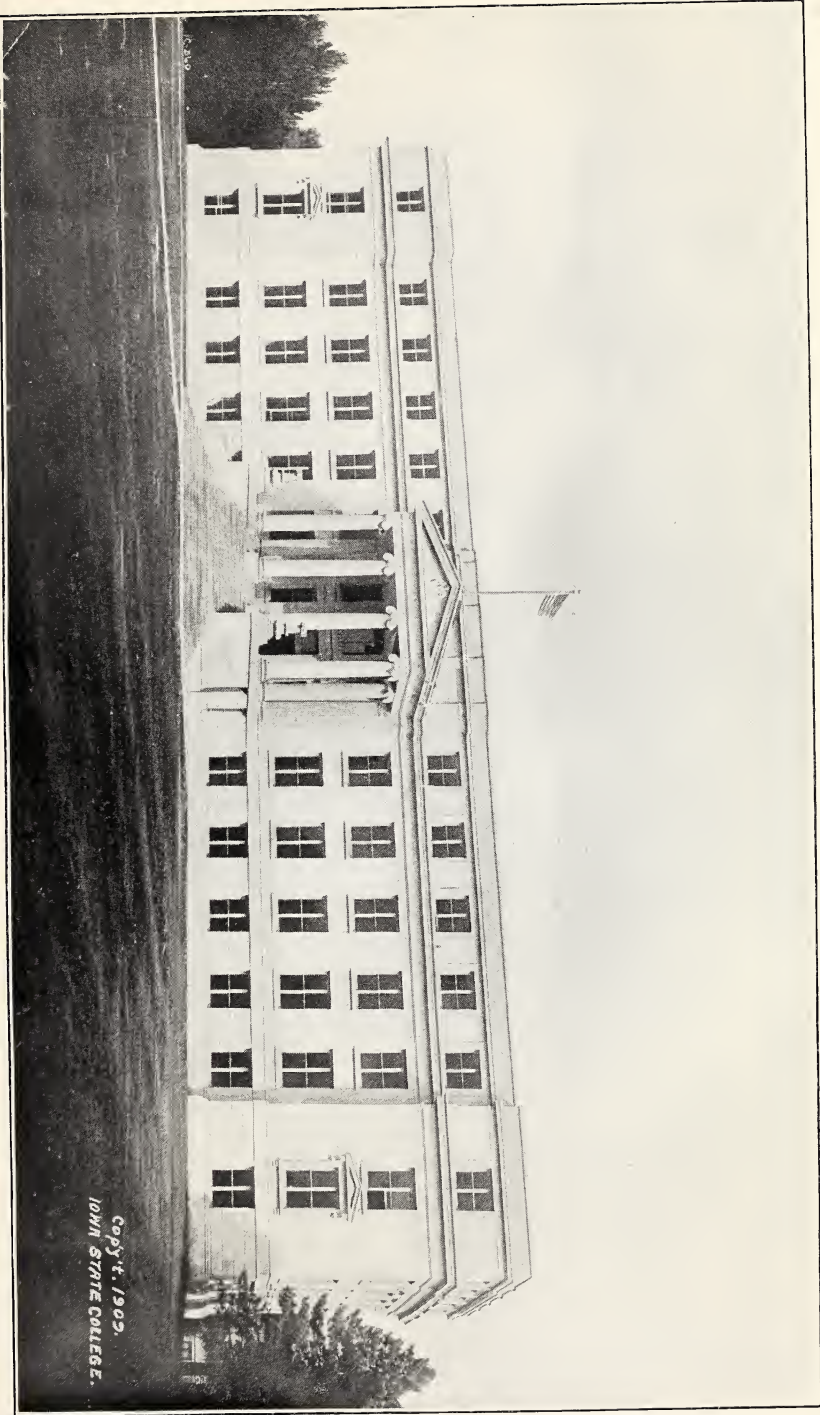
of students and permits the free circulation of air so necessary in a building of this character. Wide stairways have been provided, so that the building can be quickly emptied in case of fire. One of the most attractive features is the lighting, the windows being unusually large so that every laboratory and office is well lighted, even on dark, gloomy days. Cement floors are laid throughout the basement, all other floors being hard maple. The interior walls are of plain brick coated with cold water paint, a sage green color being used to a height of 4 feet and light yellow from that point to the ceilings, which are of wood and painted a French gray. As mill construction has been followed, the building can not readily be destroyed by fire.

Provision has been made in the building for the carrying on of instruction and research at the same time. There are 10 scientific laboratories in the building. About one-half of the basement floor is devoted to dairy work. Laboratories are provided for milk testing, cheese making, butter making, and pasteurizing. The laboratory for butter making is the largest of the four. This has a tiled floor, enameled brick wainscoting, and is finished in white. Three refrigerators are available for this work, both for storing the dairy products and for carrying on experimental investigations. The remainder of the basement is occupied by the class room for the department of dairying and farm mechanics, and a farm mechanics laboratory. This laboratory is one of the largest in the building and is fitted with forges and benches for the iron and wood work as well as being supplied with a variety of farm machinery. The offices of the dairyman and professor of farm mechanics and the mailing room are located on this floor.

On the second floor the executive offices, reading room, library, and the offices, private laboratories, and class rooms for the work in bacteriology, veterinary medicine, animal husbandry, and agronomy are located. On the third floor is located the auditorium, which has a seating capacity of about 500. The walls of this room are tinted a soft gray instead of the green and yellow. This makes the lighting especially desirable for the purpose for which this room is intended. On this floor are also found the offices, private and student laboratories, and class rooms for the departments of forestry, chemistry, entomology, horticulture, and cotton industry. A room is also provided for photographic work, and one room is devoted to the interest of the students' magazine. Each floor is provided with vaults for the storing of records.

IOWA.

The new agricultural building at Iowa State College is built in the Roman renaissance style of architecture to harmonize with the



NEW AGRICULTURAL BUILDING AT IOWA STATE COLLEGE.

COPY 'E. 1907.
IOWA STATE COLLEGE.

new central building. (Pl. X.) The building is 230 feet in length by 78 feet in width. It has a semicircular wing with 90 feet frontage, containing an assembly room and two floors devoted to laboratories. The building is fireproof throughout, of the best modern construction, and the walls are of granite and Bedford stone.

The building will provide accommodations for instruction and investigation in soils, farm crops, animal husbandry, horticulture, forestry, agricultural chemistry, agricultural journalism, and agricultural extension work. The agricultural assembly room has a seating capacity of 1,000.

The total cost of the building and furniture was about \$375,000. It is undoubtedly one of the best buildings devoted to agricultural education in America.

MAINE.

The new agricultural building recently occupied by the College of Agriculture is designed in the collegiate or Tudor style so much in use at the present time in university buildings. (Pl. IX, fig. 2.) The material used in the construction of the building is red brick, with trimmings of artificial stone, gray in color, and a slate roof. The furnishings and interior finish are in dark mission oak. The dimensions of the building are 100 by 63 feet at grade.

The building is located on a slight elevation and has two entrances to the first floor, the front or west entrance being from a vestibule leading into wide and spacious corridors which run east and west, north and south. These corridors are amply lighted and so arranged that access to them can be had from various rooms separately. Particular attention has been given to the separation of the various departments and to the placing of laboratories, lecture rooms, and other principal rooms, so as to insure economy in lighting and heating.

The basement is well above grade, and contains well-lighted and ventilated rooms for veterinary science, forestry, soil chemistry, soil and physical laboratories, photography, spraying mixtures, apparatus, tools, storage, and toilet. The toilet room is supplied with shower baths, lavatories, and lockers. The basement also contains an animal operating room, a dry kiln, and a fireproof storage vault, and is connected with the other floors by means of an elevator.

The offices of the dean are on the first floor at the right of the main entrance, and are connected with the library and a fireproof vault. On this same floor are located the departments of animal industry, college extension, and agricultural chemistry, with offices and rooms for the storage of supplies.

On the second floor are located the departments of agronomy, forestry, and bacteriology, and the museum, each department having an instructor's room or office, and plant and tool storage rooms.

On the third floor are rooms for the department of horticulture, drafting rooms, a class room, and a large lecture hall. The rooms adjoining the lecture hall on either side have movable partitions, which when opened increase the seating capacity of this hall. The horticulture department is supplied with a refrigerator and a storage room. Various laboratories are equipped with water, gas, and live steam.

About 50 feet to the rear of the agricultural building is a stock-judging pavilion, octagonal in shape, 50 feet in diameter, built of red brick, and of a style in keeping with the larger building. In this pavilion the central ring, 25 feet in diameter, is surrounded by six rows of seats, arranged in amphitheater style, and capable of seating about 350 people.

MISSOURI.

The new \$100,000 agricultural building at the University of Missouri is the second largest and doubtless the most beautiful structure on the campus (Pl. XI, fig. 1). It is four stories in height, built of native limestone, and has an aggregate floor space of about one acre.

It contains the administrative offices of the college of agriculture, the state board of agriculture, and the state dairy and food commission, and class rooms for the departments of animal husbandry, agronomy, and agricultural chemistry. There are also laboratories for students in agricultural chemistry and agronomy.

A spacious, well-lighted, well-ventilated, and well-arranged auditorium is located in a wing of the building. This auditorium seats about 1,000 people and will be used for a lecture hall during the regular college sessions and as a meeting place for large gatherings and conventions devoted to farming interests.

MONTANA.

The completion of a new agricultural building, for which the legislature of Montana appropriated \$80,000, has provided greatly improved facilities for the agricultural work, both for the station and the college (Pl. XI, fig. 2). This building is 150 feet long and 68 feet in width, with a high basement (the floor of which is on a level with the ground) and two stories above. The construction is of pressed brick with sandstone trimmings and a tile roof. The inside finish is oak, with maple floors. The floor in the main entrance and in the basement hall is of terrazzo or reinforced concrete. All the heating, water, and drainage pipes are in a subbasement, which



FIG. 1.—AGRICULTURAL BUILDING OF THE UNIVERSITY OF MISSOURI.



FIG. 2.—NEW AGRICULTURAL BUILDING, MONTANA AGRICULTURAL COLLEGE.



FIG. 1.—NEW DORMITORY OF THE RHODE ISLAND COLLEGE.



FIG. 2.—LIVE-STOCK PAVILION OF THE WISCONSIN COLLEGE OF AGRICULTURE.

makes the basement floor fully as desirable for class rooms or office as any other part of the building. The building is so arranged that greenhouses may be constructed against the south end of the building.

The main entrance faces the east. The south end of the basement is occupied by the horticultural department and the north end by the dairy department. The first floor affords space for the offices of the director, and the superintendent of farmers' institutes, library and reading room, and the offices, class rooms, and laboratories of the departments of agronomy and animal industry.

The second floor of the building is used by the domestic science department of the college, and is fully fitted up for this work.

RHODE ISLAND.

The new \$50,000 dormitory recently occupied at the Rhode Island college is unique among agricultural college dormitories, in that provision is made in it for society rooms, a bowling alley, and a room for billiards and other games (Pl. XII, fig. 1). The building is three stories high above the basement, and the two upper floors contain 48 rooms for students, all of which are well lighted by electricity and heated by steam from the central plant. There are also bath and toilet rooms on each floor sufficient to meet all needs, including enough shower baths for all athletic purposes. On the first floor there is a large reception or social room, an assembly room, which will also serve as a chapel, and an attractive dining room to seat 150 people, and connected with it pantries, a kitchen, and other service rooms. The building is constructed of native granite and covered with a slate roof.

WISCONSIN.

The new animal husbandry pavilion recently completed at the Wisconsin College of Agriculture at a cost of \$75,000 marks a step in advance in the agricultural college structures in this country, since it provides facilities not only for classes, officers, and the housing of animals, but also for large gatherings of farmers, stock sales and shows, and demonstrations (Pl. XII, fig. 2). The building fills a space of 207 by 114 feet, with a stock-judging tanbark arena, 164 by 66 feet, occupying the central space. Around this arena are seven concrete ledges upon which are grass-cloth mats providing comfortable seats for over 3,000 persons. The entire structure is of reinforced concrete with brick exterior and a green glazed tile roof.

In the basement, which extends along one side and the two ends of the building, are provisions for housing live stock, including 14 large box stalls, 22 hitching stalls, and a large foaling stall for brood mares.

One end of the basement is separated from the rest by tight doors, so that it may be isolated in case of an outbreak of disease among the animals. In this part of the building is a large veterinary operating room with a dispensary on the floor above. This basement is well provided with windows, and the King system of ventilation assures fresh air throughout the structure.

The floors are all of concrete overlaid with wooden pallets except in the arena, which is covered with tanbark. There are two exits for animals and five exits for the audience. Skylights and windows in the gables of the auditorium provide light by day, and numerous lights provide illumination at night. The building is heated by steam, has forced ventilation, and is fully equipped with dressing rooms for the use of classes of students.

In the front wings of the building are offices for the farm superintendent and animal husbandman, living quarters for the attendant in charge of live stock, offices for the veterinarian and the department of horse breeding, and a large demonstration room for class purposes.

The storage facilities for feed are especially convenient, including seven large concrete feed bins to hold grains and mixed feeds, a root cellar which will hold several tons of roots, and hay bays which will shelter over 60 tons of hay and bedding.

The auditorium is to be provided with two large drop curtains which may be used to divide it into three class rooms for students' work in stock judging. This will provide much needed facilities for this purpose for the college during the sessions of the short course when the classes in stock judging frequently include hundreds of students.

WORK OF THE COLLEGES.

The California superior court at Fresno has granted the petition of the state university for a partial distribution of the estate of the late M. Theodore Kearney. It is expected that this will terminate the protracted litigation over this matter, and that the university will thereby come into possession of property valued at over \$1,000,000, the income of which is to be applied to agricultural instruction and research in the San Joaquin Valley.

The Colorado Agricultural College and the University of Idaho have established four-year courses in forestry. The former also offers a course in practical and theoretical library science and library economy, while Idaho has added a department of veterinary science.

Louisiana University has been organized into six colleges, among which are a college of agriculture and the Audubon Sugar School. The agricultural courses have been rearranged to provide additional electives and greater opportunity for specialization. A two-year preparatory school of agriculture has also been added.

The charter of Nebraska University has been amended by the legislature to allow a reorganization into seven colleges, namely: The graduate college, the college of arts and sciences, the college of agriculture, the college of engineering, the teachers' college, the college of law, and the college of medicine. Of these, the graduate college has hitherto been known as the graduate school, and the colleges of agriculture and engineering have constituted what was known as the industrial college. The new college of agriculture is to include the university work in general and technical agriculture, forestry, and domestic science. The departments of soils and farm crops have been reorganized into a department of instructional agronomy and farm management and a department of experimental agronomy.

The work of the New York State College of Agriculture in rural economy, hitherto under the immediate direction of the dean as professor of rural economics, has been formally organized as a separate department. A further differentiation of the horticultural department has also been made through the appointment of an assistant professor of pomology.

At Ohio State University the department of horticulture and forestry has been divided, W. R. Lazenby retaining charge of the work in forestry, which has been extended to include a four-year course. Wendell Paddock has been called from the Colorado Agricultural College to take charge of the department of horticulture.

The North Dakota Agricultural College has established a four-year collegiate course in veterinary science. A veterinary department has also been established at the Montana college.

The board of regents of the University of Wisconsin has established two fellowships at \$400 a year and two scholarships at \$225 a year for graduate students in agriculture. These are to be open to graduates of colleges of recognized standing and other students with equivalent education, and both men and women are to be eligible. An experimental forestry laboratory is to be established at the university by the Forest Service of this Department in a \$30,000 building, to be erected by the university on a site adjacent to the college of agriculture. The Forest Service is to supply equipment and maintain a corps of investigators. It is expected that the laboratory will be available to the faculty and students of the university for research work, and that members of the staff will deliver lectures on forestry and related topics in the university courses as well as in a course for forest rangers to be established by the university. Among the lines of experimental work to be taken up in the laboratory are tests of various woods for paper pulp and for building materials, and the distillation of turpentine, alcohol, and resin from wood waste.

COURSES FOR TEACHERS.

The development of courses in agriculture for public-school teachers, in harmony with the provisions of the "Nelson amendment," progressed to a considerable extent in different States. The University of Maine announced a one-year course to train teachers of agriculture for secondary schools. The course is open to college graduates, to high-school teachers with at least two years' experience, and to normal-school graduates who have had three years' experience in teaching.

The University of Minnesota established in the college of agriculture a two-year course in industrial and agricultural education for the preparation of teachers in the agricultural high schools provided for in the Putnam Act, the provisions of which are described under Secondary Schools, page 314. A summer school for teachers was held for three weeks beginning June 21.

At the North Dakota Agricultural College a department of education was established in accordance with the Nelson amendment, with Arland D. Weeks as professor in charge. In addition to general courses in the history of education, psychology, adolescence, school observation, and administration, it provides a special course in agricultural and industrial education, supplemented with occasional lectures by specialists in these subjects. The new department has announced an industrial summer school for teachers during August, 1909. Instruction will be given in the regular public-school subjects and also in elementary agriculture, manual training, nature study, domestic science, agricultural botany, and agricultural and industrial education. In addition to the class-room instruction many special lectures have been announced, among which are one by Dr. A. C. True, of this Office, on The Point of View and Atmosphere in the Rural Schools; one by Dean L. H. Bailey, of Cornell University, on The Outlook for Country Life; and seven by F. W. Howe, of this Office, on different phases of public-school agriculture and country-life problems.

The University of Vermont has established a department of teaching, the work of recent years in the form of educational conferences and a summer school in elementary agriculture having prepared the way for this larger development. A course of lectures coupled with practical work was given during the year with an enrollment of over 100 students; and a summer school for teachers has been announced for the summer of 1910 to include courses in domestic science, manual training, and elementary agriculture.

Summer schools for teachers were also held in a number of institutions not mentioned above. At Storrs, Conn., there was a four weeks' course in June and July, with work in nature study, domestic science,

agriculture and methods of teaching it, and special practical courses in poultry husbandry and fruit growing.

At the Kansas Agricultural College domestic science and agricultural courses for teachers were given in May and June. The Massachusetts and Michigan agricultural colleges held summer schools similar to those of the previous year. The Tennessee college again offered scholarships at the summer school for the South to teachers desiring to take four or more hours a week of work in agriculture, and many took advantage of this offer.

In Virginia the State University at Charlottesville gave courses in educational psychology, rural school problems, history of education, agriculture, domestic science, manual training, nature study, school gardening, and teachers' training work for white teachers; and Hampton Institute continued its practice of conducting four weeks' courses in cooking, dressmaking, manual training, nature study, poultry keeping, and principles of teaching for negro and Indian teachers.

At the Iowa college evening seminars were held to aid in training teachers of agriculture and domestic science for high schools.

Oberlin College, which was the first college in Ohio to offer lectures in agriculture many years ago under Professor Townshend, but which has not given such courses in recent years, held its first summer school of methods during the six weeks ending August 6. Instruction was offered in various subjects of interest to elementary and high-school teachers, including manual training, agriculture, forestry, agricultural education, domestic science and art, nature study, and human physiology and hygiene.

The Oklahoma state department of education has established an agricultural division under the direction of the deputy state superintendent of public instruction, for the assistance of public-school teachers in agriculture, domestic science, and manual training. It plans first to promote the organization of boys' and girls' home-culture clubs.

The agricultural colleges were also unusually active in preparing courses in agriculture for public schools and other helpful literature for teachers. The Michigan Agricultural College published a brief outline for a course in agriculture for the elementary schools of Michigan, together with a similar outline for high schools, supplemented by more detailed directions for carrying on botanical work, lessons on farm crops, farm management, farm mechanics, horticulture, animal husbandry, and soils. Lists of books and bulletins suitable for the agricultural library of high schools were suggested.

The Massachusetts Agricultural College published a pamphlet entitled "Public School Agriculture," which was the work of a committee appointed at the close of a conference on agricultural science

at Amherst, Mass., in 1908, to prepare a series of teachable exercises on elementary agriculture. The exercises published number 54, distributed over the study of soils, capillarity, drainage, evaporation, earthworms, plant transpiration, fertilizers, leguminous forage plants, seed selection, corn germination, plant variation, propagation, grafting, pruning, Bordeaux mixture, milk bacteria, milk testing, and similar subjects. Twenty-four additional exercises are suggested, with a list of helpful bulletins and books.

The official journal of the Kansas Agricultural College, *The Industrialist*, has been running two special series, one a farmers' institute series, with practical suggestions for adult farmers, the other an agricultural education series, with lessons for teachers and pupils on such subjects as how plants feed and grow, plant breeding, a corn primer, tree culture, the soil, an elementary study of insects, and insects injurious to farm crops.

The extension bulletins of the Ohio College of Agriculture have appeared at frequent intervals with special school articles on such interesting and instructive topics as the horse, our useful birds, the preparation of the seed bed, propagation of plants, tillage and cultivation, what trees do, the story of the life of a moth, sheep, and what makes the wind blow.

From the agricultural department of Miami University, Oxford, Ohio, have come two useful school bulletins: *The Soil and Its Relation to Plants*, and *Experimental Studies of Plant Growth*.

The New Hampshire college has started a series of school bulletins with suggestions for teachers of elementary agriculture.

The New York State College of Agriculture has continued its Home Nature Study Course circulars for teachers and its Rural School Leaflet for teachers and pupils. The latter is said to have reached 75,000 pupils in 1909, with helpful lessons on plant food, the horse, poultry, dairying, and other related topics.

The Hampton leaflets have appeared as usual, with occasional numbers dealing with special elementary lessons in agriculture. Three such lessons appeared during the year: *The story of corn*, *plowing and harrowing*, and *culture and marketing of tobacco*.

COLLEGE EXTENSION AND SHORT COURSES.

All forms of agricultural extension work have developed rapidly during the year, and as a result of increasing demands upon the agricultural colleges for itinerant instruction and demonstration, many of these institutions have organized and manned extension departments. Some of the features of school extension work are described briefly in this report (pp. 317, 322), but a more extended account of them is given in the report of the farmers' institute specialist, on page 327.

The number and variety of short courses held at the agricultural colleges in 1909 were greater than in any previous year, and there were nearly 2,000 more students enrolled in these courses than in 1908. Massachusetts appointed a director of short courses, Oregon inaugurated short reading courses in poultry husbandry, Oklahoma held a cotton-grading school, Missouri gave two short courses for boys, and Vermont held its first annual farmers' week, with 160 enrolled.

Farmers' weeks have grown in favor and effectiveness as means of instruction for the more adult people in rural districts. They assume many different forms, but the general scope of the larger meetings of this class is indicated by the following account of farmers' weeks in Missouri, Nebraska, New York, and Oklahoma:

The "farmers' week," held at Columbia, Mo., under the auspices of the state board of agriculture, during the week of January 4, was extremely successful, attracting an attendance of over 1,000. A large number of organizations participated in the meetings, including, in addition to the college of agriculture and the state board of agriculture, the state board of horticulture, Improved Live Stock Breeders' Association, Dairy Association, Butter Makers' Association, Corn Growers' Association, Sheep Breeders' Association, Swine Growers' and Breeders' Association, Highway Engineers' Association, Jersey Cattle Breeders' Association, Bee Keepers' Association, Home Makers' Conference, and the American Breeders' Association.

The general exercises were opened by President A. Ross Hill of the university, former Secretary of Agriculture Norman J. Colman, and Dean Waters. Illustrated lectures were given by H. W. Mumford on Live Stock and Agricultural Conditions in Argentina and How They Affect the American Live Stock Industry, and by W. J. Spillman on Mendel's Law. C. A. Zavitz discussed the work of the Ontario Agricultural and Experimental Union, and Assistant Secretary of Agriculture W. M. Hays gave an address urging the betterment of general farm conditions and especially of rural schools. During the week practical demonstrations were given in soil, seed, and dairy work, stock and grain judging, and there were corn, fruit, and dairy products shows. In the "home makers' conference" a model kitchen was on exhibition and an address was given by Miss Martha Van Rensselaer, of Cornell University, on What the State May Do for Farmers' Wives.

The eighth annual joint meeting of the various state agricultural associations in Nebraska was held at the university farm January 18-22, the different organizations holding meetings including the board of agriculture, the Horticultural Society, the Veterinary Medical Association, the Dairymen's Association, Poultry Association, the Improved Live Stock Association, the Swine Breeders' Association, the Association of Breeders of Poland China and Duroc

Jersey Swine and Red Polled, Aberdeen-Angus, and Shorthorn Cattle, the Bee Keepers' Association, the Corn Improvers' Association, the Farmers' Institute Conference, and the Home Economics Association. A large number of experts from several agricultural colleges and experiment stations and from the United States Department of Agriculture participated in the various programmes. A special feature of the meetings was the dedication on January 19 of Home Economics Hall—a three-story structure of gray pressed brick, costing about \$70,000.

The exercises of "farmers' week," held at Cornell University February 22–27, were very largely attended, the registration reaching 1,275. The programme included a general reunion of agricultural students resulting in the formation of a permanent association, meetings of the State Experimenters' League, Plant Breeders' Association, Poultry Association, the Cornell Horticultural Union, the Dairy Students' Association, the newly formed State Drainage Association, and other organizations, together with a corn congress, horse show, poultry institute, housekeepers' conference, the second annual agricultural stage, and a large number of lectures and demonstrations.

A very successful week's short course was held at the Oklahoma college in January. About 400 farmers were in attendance, and 50 women attended the course in domestic economy. The subjects presented included Cotton, Corn, and Alfalfa Growing, Seed Selection, Road Building, Farm Management, Horse and Swine Judging, Dairying, Tuberculosis, Texas Fever and Its Eradication, the Silo and Its Uses, Care of Farm Horses, Orchard Pests and Spraying, Fruit Growing and Storage, and Tree Planting. A special feature of the week was a meat-cutting demonstration, conducted under a large tent in which all the retail cuts of beef, pork, and mutton were shown and their relative value explained. The State Dairymen's Association held its annual meeting during the week, and a corn growers' association was organized with over a hundred charter members.

THE COLLEGES AT THE INTERNATIONAL LIVE STOCK EXPOSITION.

The ninth exposition of the International Live Stock Association, held in Chicago, November 28–December 10, was again a notable success. In spite of the quarantine of several States on account of the outbreak of foot-and-mouth disease, 20 States, together with Canada, Mexico, England, and Belgium, were represented by entries including over 3,000 animals, and in most of the classes the quality showed continued improvement over previous years.

The influence of the agricultural colleges and experiment stations was quite as strongly in evidence as ever. Their staffs furnished six

members of the corps of judges, their students were again a prominent and distinctive feature, and their exhibits were distributed through nearly every class of entry, figuring even more largely than in former years in the prize winnings, easily predominating in the fat-stock classes and achieving several grand championships, among them the highly coveted championship of the single steers.

In the fat-barrow class the grand championships both for single barrows and pens of 3 were won by Berkshires from the Iowa college, which also furnished the champion Poland China and large Yorkshire single barrows, the champion Duroc Jersey pen of 3, and the champion carload of from 150 to 200 pounds in weight, besides a large number of class prizes. The champion pen of Chester Whites and the champion Duroc Jersey single barrow were from the Wisconsin University, which also won a long list of class prizes. The Ohio University showed the champion pen of large Yorkshires and won several prizes in other classes, as did also Purdue University.

The exhibit of fat wethers from the Wisconsin University was especially noteworthy and won a large number of prizes, among them the championships for pens of Shropshires and Cheviots, for single wethers in Hampshires, and for the champion dressed carcass of the show. Iowa received a second prize for a pen of Southdowns.

For fat cattle the Nebraska University won, in the Shorthorn classes, first on senior yearlings, and Ohio first on junior yearlings, and other prizes went to Missouri, Minnesota, Iowa, and Ohio. On Aberdeen Angus herds, the Kansas college won first, with Minnesota second, Nebraska third, and Iowa fifth. On two-year-olds the Kansas college was first, Purdue second, and Nebraska third; on yearlings, Minnesota first, Purdue fourth, and Kansas fifth; and on calves, Kansas first, Nebraska second, Iowa fourth, and Missouri fifth. The breed championship for single steers was again won by the Minnesota University. On Hereford two-year-olds the Nebraska University won third place and Purdue fourth.

The Missouri and Nebraska universities were strongly in evidence in the Galloway classes, the former winning the herd championship, first on yearlings, and second on two-year-olds and calves, and the latter receiving second on herd, first on calves, second on yearlings, and fourth on two-year-olds. Purdue won third and Ohio fourth on yearlings, and Kansas third on calves.

In the grades and cross breeds the Iowa college won first on herd, second on two-year-olds, second and fourth on senior yearlings, third and fourth on junior yearlings, third and fifth on senior calves, and second on junior calves. Nebraska received thirds on herd, two-year-olds, and senior yearlings, and Missouri fourth on two-year-olds and second on junior yearlings.

Upon the final assembling of the winners from all breeds, champions were as usual chosen for the groups by ages, and two of the three selected were from the college entries. For the two-year-olds the Angus Fyvie Knight from Purdue was selected, thereby reversing an earlier decision in which first place for Angus two-year-olds had been given to Ideal from the Kansas college. Symboleer, also an Angus from the Kansas college, received the calf championship. The grand championship for all breeds and ages fell to Purdue on Fyvie Knight. The Iowa college won the herd championship with Kansas third.

In the cattle slaughter tests an innovation was the ante-mortem rating of the animals from the killing standpoint. In this first place in the two-year-old class went to an entry from the Minnesota University, with Iowa third, and Missouri fourth, and in the yearling class Iowa received second and fourth place. Upon a regrading of the carcasses after slaughter, with the criterion largely the requirement of the general trade, the ratings were very much altered, Nebraska receiving first and Missouri second on two-year-olds, and Iowa fifth on yearlings.

In the carload-lot competition a load of "short fed" Angus yearlings fed by the Purdue Station under known conditions attracted much attention, and was regarded as a valuable demonstration.

The entries of horses from the colleges were much less numerous than those of fat stock. With Clydesdales Iowa received fifth prize for aged stallions and third for yearlings.

In the special class for college and station stock the competition was, as usual, exceedingly close. With cattle, Purdue won first for two-year-olds, and the championship for single steers with Fyvie Knight. Kansas won second place on two-year-olds, with Nebraska third, and Iowa fourth. For cattle one to two years old, the winner was Minnesota, followed by Iowa, Nebraska, and Missouri. For calves, Kansas won first, Minnesota second and fourth, and Iowa third. The herd championship was won by Iowa. Wisconsin took all the prizes for sheep except third on wether lambs, which went to Iowa. Purdue received second and Iowa third for barrows under 12 months, and the remaining prizes for hogs went to Iowa.

The usual large attendance of students led to the remark from The Breeders' Gazette that "more and more the International is becoming an elective course in the curriculum of agricultural colleges." The judging contests were participated in by teams from eight institutions, and several others were represented in the crowd of spectators, and at the annual meeting of the American Federation of Agricultural Students, which was held December 1. In the contest for the trophy offered for the highest total scores in judging horses, cattle, sheep, and swine, first place was awarded to the Iowa

college, the remaining competitors in order being Nebraska, Texas, Missouri, Kansas, Ohio, Ontario, and Minnesota.

The Armour scholarships contingent upon these contests and upon the prize winnings of the colleges and stations have been awarded, Iowa receiving 7, Nebraska and Wisconsin 3 each, Purdue 2, and Kansas, Minnesota, Missouri, Ohio, and Texas 1 each.

NATIONAL ASSOCIATION OF STATE UNIVERSITIES.

At the convention held at Washington, D. C., November 16 and 17, the committee reports and papers considered were chiefly concerned with administrative matters in connection with state universities. Of these two dealt with problems having an important bearing on institutions for agricultural education, viz, the report of the committee on standards, and a paper on university extension in state universities. The report of the committee on standards, which was preliminary in nature, defined the standard American university as an institution: (1) Requiring for admission the completion of a standard American high-school course of four years (not less than 14 units of 5 periods each); (2) offering in the College of Liberal Arts and Sciences two years of general work completing or supplementing the high-school course; (3) offering further two years of university work leading to the bachelor's degree, and "reaching forward to the continuation of this work in the graduate school or the professional school;" (4) offering professional courses in law, or medicine, or engineering, based upon the completion of two years of college work, and (5) offering in the graduate school an adequate course leading to the degree of doctor of philosophy. The committee recommended further that not less than 60 units of college work be required for the bachelor's degree; that the qualifications of teachers in the high school should be not less than the bachelor's degree and ought to be the master's degree; that as a rule professors of all grades of college work should have the degree of doctor of philosophy or its equivalent; that professors giving instruction in graduate work should further show their scholastic ability by successful research and publication and by demonstration of their ability as teachers; that adequate libraries, laboratories, and other equipment should be provided; that three years or 45 units from the beginning of the junior year be required for the degree of master of arts, and five years or 75 units for the degree of doctor of philosophy, and with work in residence, and that to be a standard university an institution shall be equipped to give instruction leading to the degree of doctor of philosophy in at least five departments and shall have at least one university professional school requiring two years of college training for admission.

The paper on University Extension in State Universities was presented by L. E. Reber, director of extension work in the University of Wisconsin. This dealt largely with the extension work conducted by that university, which is planned to reach ultimately all classes of people in the State. There will be a central organization reaching out to all parts of the State through lectures, publications, demonstrations, correspondence, various traveling equipments, the services of specialists and traveling teachers, study outlines, and reading and correspondence courses. The State will also be divided into districts in each of which there will be a university representative with assistants. The plan is a very elaborate one and seems to be well designed to extend greatly the influence of the university. Some of its features as applied to agricultural extension work were described in *Progress in Agricultural Education*, 1908.

HORTICULTURE AT SMITH COLLEGE, NORTHAMPTON, MASS.

In 1900 horticulture was first offered at Smith College as an elective in the department of botany, with Dr. W. F. Ganong, head of the botanical department, and Edward J. Canning, head gardener of the botanic garden, as teachers. At this time the only equipment for the work in horticulture was one small room and a portion of a small greenhouse. However, the course soon became so popular that in 1904 the college built a laboratory to accommodate 28 students and turned over the whole of one greenhouse to the work in horticulture. Each year since that time more students have elected horticulture than could be accommodated, and on this account the 28 students admitted to the course have been selected largely from the junior and senior classes.

The course extends over one year, the first two terms of which are devoted to plant manipulation, propagation, and improvement, and the third term to landscape gardening, trees, and shrubs.

The course in plant manipulation includes the study of soils, mixing soils for different purposes, every method of potting, staking, and tying plants, together with the study of insect pests and fungus diseases and materials and methods for controlling the same.

In the course in plant propagation, attention is given to propagating by green cuttings, hardwood cuttings, seeds, layering, budding, and grafting, and to the study of propagating houses and greenhouse construction generally.

In plant improvement, the students take up crossing, pollinating, hybridizing, and plant breeding generally, together with the effects of stimulants upon plants. Under this heading the subject of watering and the effects of different temperatures in their relation to plant growth is also taken up. Attention is also given to the study of the

important groups of plants, such as palms, ferns, orchids, cacti, aquatics, and miscellaneous greenhouse plants.

The course in landscape gardening includes not only a thorough study of trees and shrubs suitable in landscape work and of the landscape use of lawns and vistas in relation to surrounding objects, but also the drawing of plans, a study of types of landscape gardening in relation to the natural scenery, vegetation, climate, and other factors, and a study of the interrelations of the accessories in landscape gardening.

In addition to the special equipment for work in horticulture, the students have access to the excellent botanical equipment of Smith College, which includes separate laboratories for the study of plant physiology, elementary botany, cryptogamic botany, and other divisions of the subject, a botanic garden with over one thousand species of hardy plants and a collection of about five hundred species of trees and shrubs arranged on the campus in botanical sequence.

THE SECONDARY SCHOOLS.

From a recent compilation of data concerning the status of secondary agricultural instruction in the United States at the close of the year ended June 30, 1909, it appears that there were 60 agricultural high schools or definitely secondary agricultural courses in colleges, between 300 and 400 public high schools and academies teaching agriculture, 109 state or county normal schools, and 16 agricultural colleges training young men and women to teach the more elementary phases of agriculture, and quite a number of private colleges and schools giving instruction in agriculture of secondary grade or correspondence courses which are approximately of secondary grade, making in all about 500 institutions giving secondary instruction in agriculture. There are probably more than 400 public high schools giving instruction in agriculture, but the figures given are based upon definite returns from schools on the mailing lists of this Office.

From these returns it appeared that out of 335 high schools sending data, 309 were teaching agriculture as a separate and distinct subject in the course, while 26 were teaching it incidentally in connection with other science work. Disregarding for the purposes of this inquiry the schools teaching the subject incidentally, it was found that 47 public high schools were giving four-year courses in agriculture; 11, three-year courses; 38, two-year courses; 90, one-year courses; and 123, courses representing various fractions of a year. The average length of time devoted to agriculture was a little less than 1.5 years. These schools represented a total enrollment of 54,700 pupils, with an average of 177 to each school; and a total enrollment

in agricultural classes of 9,500, with an average of 31 pupils in agriculture to each school.

It is apparent, therefore, that the number of schools offering secondary courses in agriculture is rapidly increasing, that the public high schools are taking hold of the work with commendable zeal and that the movement is widespread, 34 States being represented in the above compilation.

RECENT PROGRESS BY STATES.

ARKANSAS.

An appropriation of \$160,000 has been made by the Arkansas legislature for four secondary agricultural schools. The State has been divided into four districts and governing boards have been appointed to locate the schools and manage them.

GEORGIA.

All of the schools provided for by the act of the general assembly of Georgia of 1906, creating a school of agriculture and mechanical arts in each congressional district of the State, were in operation in 1909. With the inauguration of these 11 schools, Georgia has in operation a definite system of agricultural education beginning with the common schools and extending through a four-year college course.

Instruction in agriculture in the common schools is under the general supervision of the state school commissioner and more directly under county school commissioners. The State College of Agriculture cooperates with these officers through one man, who gives all of his time to the organization of boys' and girls' industrial clubs, for the growing and studying of corn, cotton, and garden products and the raising of farm animals. These clubs have been in operation since 1906.

Having finished the common school course, pupils may enter one of the district agricultural high schools for a four-year course, which will fit them for life on the farm and at the same time prepare them to enter the State Agricultural College at Athens, where they may specialize along several different lines in agriculture to prepare more fully for the vocation of farming or for scientific work in the agricultural colleges and experiment stations. Young women graduating from the district schools may continue their industrial studies in one of the two normal schools located, respectively, at Athens and Milledgeville. The State is also provided with an agricultural college for white boys at Dahlonaga, a college for negroes at Savannah, and several private schools giving instruction in agriculture.

During the year ending June 30, 1909, 1,001 students were enrolled in the district agricultural schools. These students were charged from \$6 to \$10 a month for board and the actual cost of board averaged \$6.30. The students were paid about 10 cents an hour for productive labor and with the allowance thus made were able to attend one of these institutions for nine months at a net cost of from \$50 to \$60.

The total number of acres in school farms was 3,083, an average of 280 acres in each farm. The students cultivated 738 acres of this land, 100 acres were rented, 170 acres in cotton, 415 acres in grain, 543 acres in pasturage and other crops, and the remainder in wood lots and waste land. The total value of farm products in 1909 was \$16,050.

The equipment of these schools includes from one to four brick buildings, all of which were designed by the state architect and are similar in plan and materials. The principal building in each case is the academic building with four large class rooms, chemical, agricultural, and biological laboratories, an office, and cloak room on the first floor, and an auditorium, with a seating capacity of 600, and two class rooms connecting with the auditorium on the second floor. Each school is also provided with a boys' dormitory and several of the schools have also a girls' dormitory. The former is a two-story building with 42 bedrooms, 8 bath tubs, 8 toilets, 4 linen closets, and a large reception hall. Each bedroom has two windows and one closet and is designed for two students. The girls' dormitory is similar, except that each room has two closets, and the domestic science department occupies one section on the ground floor, including a kitchen, model bedroom, model dining room, a class room, a storeroom, pantries, and sinks with hot and cold water. Other buildings, such as barns, stables, dairies, and laundries, have been erected by student labor at several of the schools. In all but two of the schools electric lights are supplied either by the neighboring town free of charge or from the school plant. Each school has its own system of water-works and sewerage and in eight of the districts these systems were given by the neighboring towns. The total value of the school plant in the 11 districts is estimated at \$732,000. This includes, in addition to the farms and buildings, agricultural laboratory equipment, \$275; chemical laboratory equipment, \$505; physical laboratory equipment, \$385; other science and engineering equipment, \$400; library (1,920 volumes), \$975; dairy equipment, \$935; laundry equipment, \$4,090; shop equipment, \$2,900; domestic science equipment, \$1,715; and tools and implements, \$3,550.

The income of the schools for 1909 was \$120,800, which included \$101,750 from the State, a gift of \$3,000 to one school, and farm receipts amounting to \$16,050. The income from the State for each

school included \$7,250, arising from the fertilizer fees, and \$2,000 appropriated by the general assembly.

The president of the state agricultural college in his annual report on the work of the district agricultural and mechanical schools points out that the most urgent need of the schools at the present time is the equipment and organization of laboratory work and the adoption of good business system to cover the receipts and expenditures of the state appropriations. He believes that the bond of union and sympathy existing between the schools and the state college of agriculture should be strengthened, and to this end recommends that an annual conference of the principals at Athens be authorized for the purpose of considering all fundamental problems and encouraging cooperative activities. He is also of the opinion that the efficiency of the schools will be largely determined by the observation of a uniform course of study.

IDAHO.

A law was passed by the last legislature of Idaho dividing the State into two educational districts. In each of these a secondary agricultural school is to be established by the regents of the university and at their discretion a branch experiment station. The course of study for the schools is to have for its major function "vocational education in agriculture and in farm home making, not neglecting subjects of broadly educational value, and shall articulate such studies with agriculture and home economics courses of the State College of Agriculture above and the consolidated rural schools below." The work of the branch stations "shall be especially directed to the solution and demonstration of the agricultural problems of the respective districts in which the stations are respectively located."

INDIANA.

The name of Winona Agricultural Institute has been changed to Winona College of Agriculture. It now offers a two-year "practical" course with fall, winter, and spring terms, a two-year "special" course running six months each year, and "advanced work in agriculture, or college work in the sciences, English, languages, literature, mathematics, history, education, or philosophy."

A good example of public school work in agriculture is found in Thorntown, Ind., a village of 2,000 inhabitants, having a high-school enrollment of 85 pupils. Nearly 60 per cent of these come from the surrounding farms and about 60 per cent are boys. All third-year pupils take agriculture as a required subject, five hours a week for text-book work and about two periods a week for laboratory work and field exercises.

LOUISIANA.

The legislature of Louisiana passed a law for the encouragement of agricultural teaching in high schools and voted \$500 to each school maintaining a course approved by the state board of education.

MARYLAND.

An agricultural and industrial school for negroes has been established at Sandy Spring, Montgomery County, Md. The purpose of the institution is to give instruction in agriculture, mechanics, and household arts, and to prepare teachers to teach agriculture in the rural schools. George H. C. Williams, former instructor in biology at Armstrong Manual Training School, Washington, D. C., is the principal.

MASSACHUSETTS.

Smith's Agricultural School and Northampton School of Technology was opened to students, and at the close of the first week the enrollment was 114, of whom 30 were girls in the household economics course, 30 boys in the agricultural course, and 54 boys in the mechanic arts course. The agricultural course for the first year includes soils and plant life, physical geography, elementary science, practical arithmetic, bookkeeping, free-hand drawing, English, algebra, American history, civil government, and mechanical work; for the second year, animal husbandry, botany, farm chemistry, farm physics, plane geometry, English, general history, and mechanical work. The course in mechanic arts during the first two years is the same as that of the agricultural course except that chemistry, mechanical drawing, and shop practice take the place of soils, plant life, and animal husbandry, and the household economics course differs from the agricultural course only in offering sewing or cookery in place of soils, plant life, and animal husbandry. Applicants for admission to this school who are graduates of rural schools, or who have passed the ninth grade in other schools, and are 14 years of age or older, may be admitted without examination.

A new agricultural high school has been established at Montague with a graduate of the Massachusetts Agricultural College as teacher of agriculture.

MICHIGAN.

The North Adams high school added an agricultural course to its curriculum, in charge of R. C. Carr, a graduate of the Michigan Agricultural College. The course was conducted under the direction of W. H. French, professor of agricultural education at the college,

who has published a bulletin concerning it, from which the following data are taken:

In a school population of 121 there is an attendance of 42 non-resident students. Forty of the 43 high-school boys are now studying agriculture, and 4 of these had previously graduated or had left the high school.

The agricultural course is arranged as follows: Ninth grade—general and agricultural botany, a half year each; tenth grade—horticulture and field crops, half year each; eleventh grade—live stock, dairying, and poultry, entire year; twelfth grade—soils, one-half year, and farm management and farm mechanics, half year. In response to a strong demand from the surrounding country the school also gave a farmers' short course of one evening lecture each week for ten weeks to an average attendance of 25.

Some conclusions drawn from the year's observations are that the practical applications of the agricultural instruction have greatly increased the interest in the high school and have "steadied" the work of the entire school; that agricultural instruction gives point and value to all other high-school work in science, arithmetic, and language; that it can be successfully given under ordinary high-school conditions; and that it has furnished at least as much training in thought and judgment as any of the traditional studies in the curriculum.

MINNESOTA.

Stephens Hall, the three-story dormitory recently erected at the Crookston Agricultural School at a cost of about \$43,000, was dedicated September 17, 1908. The speakers included Hon. J. J. Hill, who was the orator of the day; Congressman C. R. Davis; Prof. William Robertson, of the school; P. M. Ringdahl, president of the board of control; state superintendent of public instruction, John Olson, and Director Randall, of the Minnesota University and Station. An industrial building, costing about \$15,000, and containing a lecture room, creamery, and blacksmith and carpenter shops, is nearing completion.

The legislature of Minnesota passed what is known as the Putnam Act, providing state aid for 10 high schools or consolidated rural schools which maintain agricultural and industrial departments. The State will pay two-thirds of the expense to maintain these departments, provided that each school employs trained instructors in agriculture, manual training, and domestic science, possesses not less than 5 acres of land, suitable for school gardens, and experimental and demonstration purposes, and that the total state expenditure for each school does not exceed \$2,500.

The 10 schools selected are the high schools at Albert Lea, Alexandria, Canby, Glencoe, Hinckley, Red Wing, and Wells, the



FIG. 1.—CONSOLIDATED SCHOOL, LEWISTON, MINN., AND SCHOOL VANS ON RUNNERS.



FIG. 2.—CLASS TESTING SEEDS FOR PURITY AT LEWISTON (MINN.) CONSOLIDATED SCHOOL.

high schools and associated rural schools at Cokato and McIntosh, and the consolidated school at Lewiston (Pl. XIII). The act also provides that not to exceed 10 schools may be added to the list during each succeeding biennium. In addition to the 10 schools operating under the Putnam Act, seven schools have organized departments of agriculture, domestic science, and manual training under special teachers. These schools are located at Argyle, Arlington, Dennison, Eagle Bend, Fergus Falls, Morris, and Warren.

MISSISSIPPI.

Fifteen counties in Mississippi located schools under the act of 1908, which authorized boards of supervisors to vote a tax levy of not to exceed 2 mills for the support of county agricultural schools and provided state aid to the extent of \$1,000 for each school. The first of these was Noxubee County, which voted a tax levy of 1 mill upon the taxable property of the county for the support of its county agricultural high school at Mashulaville, an inland village 12 miles west of Macon. This school will have an income of \$1,000 from the State, \$1,000 from the public schools merged into it, and \$5,000 from the county, making an annual income of \$7,000.

NEW YORK.

A considerable number of the public high schools and some of the older academies and seminaries have provided for instruction in agriculture. At Albion, in Orleans County, agriculture was taught during the year to 12 students who elected this course in the high school. This work was in charge of the instructor in science, and the nature of the course is indicated by the following outline:

AGRICULTURE IN THE HIGH SCHOOL AT ALBION, N. Y.

A. Soil:

- 1, Definition. 2, Origin. 3, Function. 4, Kinds. 5, Physical composition. 6, Physical structure. 7, Chemical composition. 8, Drainage. 9, Enriching.

B. Plants:

- 1, Structure. 2, Physiology. 3, Propagation and breeding. 4, Food. 5, Proper environment. 6, Use.

C. Animals:

1. Classification. 2. History of domestication. 3. Physiology. 4. Foods and rations. 5. Products. 6, Breeding. 7, Management.

D. Farm mechanics.

- 1, Farm architecture. 2, Road construction. 3, Use and care of farm machinery. 4, Ventilation and sanitation. 5, Weather forecasting.

E. Fruit growing.

- 1, Soil. 2, Tillage. 3, Fertilizing. 4, Plant. 5, Pruning, grafting, and budding. 6, Diseases and insects. 7, Spraying and spraying mixtures. 8, Harvesting and marketing.

Each student is required to perform the following exercises in the laboratory or elsewhere and to keep a written record of the results, with drawings of the apparatus, specimens, and other items:

- | | |
|---|---|
| 1. Soil formation. | 22. Study of plant foods. |
| 2. Types of soil and subsoil. | 23. Study of corn. |
| 3. Relative productivity of soil and subsoil. | 24. Study of potato. |
| 4. Separation of soil particles. | 25. Study of legumes. |
| 5. Microscopical examination of soil particles. | 26. Determination of the depth for planting seeds. |
| 6. Effect of humus and lime on clay soil. | 27. Determination of purity of seeds. |
| 7. Quantitative determination of water and organic matter in soils. | 28. Study of grafting and budding. |
| 8. Air in soils. | 29. Pruning. |
| 9. Acid effect of carbon dioxide on water. | 30. Diseases of fruit trees and fruit. |
| 10. Effect of lime on acid soils. | 31. Fruit-tree insect pests. |
| 11. Soil solutions. | 32. Fruit-tree fungi. |
| 12. Soil temperature. | 33. Preparation of spraying mixtures and their use. |
| 13. Soil capillarity. | 34. Methods of sorting and packing fruit. |
| 14. Soil evaporation. | 35. Study of bacteria and molds. |
| 15. Effects of tillage. | 36. Fruit storage. |
| 16. Surface drainage vs. tile drainage. | 37. Balanced rations. |
| 17. Determination of lime in soil. | 38. Care and management of horses. |
| 18. Tests for starch, sugar, and albumen. | 39. Care and management of cows. |
| 19. Osmotic pressure. | 40. Care and management of sheep. |
| 20. Study of transpiration. | 41. Judging stock. |
| 21. Study of germination. | 42. Poultry raising. |
| | 43. Study of farm buildings. |
| | 44. Farm machinery. |
| | 45. Study of weather maps. |

Three forty-five minute periods and two ninety minute periods each week for forty weeks are devoted to the subject. Bailey's "Principles of Agriculture" is used as a text, supplemented by bulletins obtained from the New York state experiment stations and Farmers' Bulletins from the United States Department of Agriculture, and by other literature upon the subject written by Osterhout, King, Bailey, Wing, Roberts, Voorhees, Brooks, and others.

OKLAHOMA.

In accordance with the law passed by the first state legislature of Oklahoma providing for the establishment and maintenance of agricultural schools of secondary grade in each supreme court district of the State, five schools were located as follows, the numbers in parentheses corresponding to the numbers of the judicial districts: (1) Conners State School of Agriculture, Warner; (2) Murray State School of Agriculture, Tishomingo; (3) Haskell State School of Agriculture, Broken Arrow; (4) Cameron State School of Agriculture, Lawton; and (5) Fifth District State School of Agriculture,

Helena. A sixth school, known as the Panhandle Agricultural Institute, was established and located at Goodwell. Each of the first five schools has an appropriation for the first year of \$20,000 for buildings and \$12,000 for maintenance. The sixth school is designed to serve only part of a district and begins its work with a building fund of \$12,000 and a maintenance fund of \$5,000 the first year and \$7,000 for the second year. One-fourth of the maintenance fund for each school must be expended in developing agricultural experiments in the field, barn, orchard, shop, and garden.

PENNSYLVANIA.

In addition to the very large appropriations for the Pennsylvania College and Station, noted elsewhere in this review, the legislature appropriated \$40,000 for the State Forest Academy at Mount Alto and \$25,000 for the National Farm School at Doylestown.

TENNESSEE.

The University of Tennessee conducted for a part of the year a unique plan of agricultural extension work in 11 high schools of that State. The plan was designed to illustrate in its practical results the cultural value of instruction in agriculture to the students of secondary schools as well as its usefulness to those who may some time follow the business of farming.

Briefly described, this plan provided for the monthly visitation of these schools by the head of the university department of agricultural education who gave at each visit a lesson and a demonstration, accompanied by an outline of work to be done the next month, together with suggested readings and reviews. He also gave occasional popular lectures on education in connection with these visits. All of the expenses of this supervision and visitation were borne by the university except in cases where the local community provided entertainment, but each school was required to assume responsibility for the success of the work by giving it a regular place in the school programme, providing for a regular teacher in the classes between visits, and making arrangements to continue the work from year to year, so long as the university offers cooperation, and ultimately to maintain the work independently as soon as financial support and other conditions justify. The expenses for material equipment for the work was estimated from a minimum of \$10 to whatever the school chose to provide annually.

Each lesson given by the visitor presupposes the mastery of all former lessons, thus making the work cumulative and capable of increasing technicality. Plans were made to collect a series of lessons

into a printed and illustrated form which would be available to succeeding beginners' classes in each school without the necessity of much supervision. In this way the list of schools and trained teachers would be developed together, and schools that drop out of the list would be succeeded by new ones from the waiting list.

Several important advantages at once suggest themselves in this plan, considered as a whole, and the legislature indicated its approval of the experiment by passing an act granting financial aid to high schools introducing agriculture, domestic science, and mechanic arts. Such a plan makes effective use of existing secondary schools. It takes these schools and teachers as they are, and develops the new work without displacing their present mechanism or personnel. It gives opportunity for the demonstration of valuable results before calling for anything but nominal local expenditures in support of the work installed. In short, it seems perfectly adapted to existing conditions while affording the means of constantly improving them through the new impulse which must come with the wise introduction of agricultural instruction as a subject of general cultural value in secondary schools.

TEXAS.

The legislature of Texas at its last session appropriated \$32,000 to provide a fund from which the state board of education is to duplicate amounts, not less than \$500 nor more than \$2,000, that shall have been appropriated by the trustees of any common school district or independent school district to the establishing, equipping, and maintaining of departments of instruction in agriculture, including courses in manual training and domestic economy "subsidiary to agriculture." State aid shall not, however, be given more than twice to the same school, and the geographical location of the school shall be considered with a view of locating such a school, if possible, in each of the senatorial districts of the State. Unlike many of the acts intended to promote instruction in agriculture, this one makes it obligatory on the part of the school board to provide laboratories for instruction in botany, zoology, and other elementary sciences related to agriculture, and land for the production of farm and garden plants, and to employ a teacher who has received special training in agriculture and allied branches.

VIRGINIA.

As noted in *Progress in Agricultural Education, 1908*, the legislature of Virginia appropriated \$20,000 to be used in maintaining courses in agriculture, domestic science, and manual training in at least one high school in each of the ten congressional districts in the State. The first high school to take advantage of this legislation was



FIG. 1.—A FARMERS' INSTITUTE AT THE NEW BUILDING OF THE MANASSAS AGRICULTURAL SCHOOL.



FIG. 2.—MILITARY TRACT NORMAL SCHOOL, MACOMB, ILL.

the one at Manassas, Va., which began work in the subjects provided for in the act of the legislature in the fall of 1908. On November 14, 1908, this school, with appropriate ceremonies, laid the corner stone for a new agricultural high-school building, which has since been completed and occupied (Pl. XIV, fig. 1).

Eight other schools introduced courses in agriculture during the year and received the benefits of the legislative appropriation. These schools were located respectively at Appomattox, Burkeville, Chester, Cortland, Elk Creek, Hampton, Lebanon, and Middletown.

AGRICULTURE IN NORMAL SCHOOLS.

The normal schools all over the country are responding as rapidly as their resources will permit to the demands made upon them for teachers having some knowledge of the principles of agriculture. As indicated in previous reports several of the States have made definite provisions for the teaching of agriculture in normal schools. Among the more recent legislative acts bearing on this phase of the educational movement is that of the legislature of Texas, which at its last session appropriated \$2,000 a year for two years to each of its state normal schools, which are located respectively at Huntsville, Denton, and San Marcos, for the purpose of installing, equipping, and maintaining departments of agriculture, manual training, and domestic science, in which subjects instruction shall begin not later than the autumn of 1909. The act also made provision for the introduction of teachers' courses in elementary agriculture in the summer sessions of these three normal schools—the College of Industrial Arts for Girls, at Denton, and in summer sessions at the Agricultural and Mechanical College and the State University. For the support of this work \$3,000 annually was appropriated to be divided equally among the six institutions.

The normal and industrial schools for girls at Rock Hill, S. C.; Milledgeville, Ga.; Montevallo, Ala.; Columbus, Miss.; and Denton, Tex., are among the institutions which now have definite departments of agriculture and provide courses of instruction in this subject for the young women who attend their classes.

The normal schools of Illinois during the past year have come into closer touch with the interests of their farming constituency by holding a number of farmers' institutes at the schools. An association of country teachers was formed at a meeting held at the Macomb Normal School (Pl. XIV, fig. 2), July 22–23, to be known as the Country Teachers' Association of Illinois, and having as its main purpose to increase the usefulness of the country school by improving its physical and social environment and enriching its course of study in such a manner as will bring the child into sympathetic and vital relationship with his environment, by country school extension work through the

different educational institutions, offices, and agricultural associations, by consolidating weak country schools, by encouraging more thorough preparation, larger salaries, and longer tenure of positions for teachers, and by the further development in state normal schools of facilities for training country school-teachers.

A similar association of agricultural school-teachers has been formed in Wisconsin, and another in Nebraska.

The teachers of New Jersey were fortunate in being able to attend a very successful summer school of agriculture and industrial arts at Cape May, from August 6-31, 1908. The work in agriculture was in charge of Mr. H. O. Sampson, of this Office, who was assisted by Miss Laura E. Woodward, nature-study teacher in Trenton city schools, and Mr. Earle Anderson, a pupil of the Calvert Agricultural High School. The instruction was carried on by lectures, laboratory demonstrations, and field trips, no text-book being used. The aim of the instructors in the agricultural classes was to give the student teachers work that could be taken up in the schools of the State where no special equipment, as expensive laboratory apparatus, is placed at their disposal. For example, they were taught how to use tin cans, plates, bottles, and similar articles in the working of experiments. One of the experiments was the testing of small seed for germinating power by the use of an old plate, a handful of sand, and a piece of muslin as the materials needed to make the tester. Another experiment was the testing of seed corn for germination by using a yeast box, some sawdust, and a square of cloth. A further demonstration to show why clay is stickier than sand was made by using two glass lamp chimneys, some sand and water as the material needed, the aim in the experiments being to use materials that can be easily procured by any teacher.

All of the agricultural work was made as practical as possible. Thus, when a lecture on grafting was given, the students were required to bring models of their own construction that illustrated the principles given in the lecture; when they were taught that water passes out of small holes in the leaves of plants they proved the statement by placing a tumbler over a small growing plant and watching the moisture collect on the inside of the tumbler, this moisture coming from the leaves of the plant in the form of an invisible vapor and being condensed by the coolness of the glass.

Domestic animals were studied by having representatives of the different classes of live stock before the students while stock lectures were given. At one of these lectures two Jersey cows were brought before the class. One was somewhat beefy, had a short, thick neck, and departed somewhat from the ideal wedge shape desired in a dairy animal, while the other one was lean, with bones protruding, and possessed the wedge shape desired. These two were compared

in detail and reasons given why the one that approached more nearly the dairy standard was probably the better animal.

One of the features of the course was a model school garden planted on the school yard at Cape May, to show the students how to arrange a garden on their own school yards. This garden was planted to varieties of vegetables grown in New Jersey and the instruction given regarding such work was made to fit conditions found in New Jersey schools.

THE ELEMENTARY SCHOOLS.

There are now 14 States that require the teaching of agriculture in the elementary schools, Arkansas having passed a law to this effect in 1909. While the number of States making such requirements is increasing from year to year, and the number of individual teachers making a success of such work is also growing, the main effort now seems to be to reach first the high schools and the normal schools and thus prepare teachers and subject-matter for successful work in the elementary schools. As noted elsewhere in this review, the agricultural colleges and the state and county normal schools are actively engaged in developing facilities for the training of teachers, and both the colleges and the state departments of education are aiding the movement by preparing and publishing leaflets and other literature for use in the elementary schools.

On the other hand, less formal instruction in agriculture than was at first attempted in the elementary schools, such as boys' and girls' agricultural club work, judging contests, domestic science contests, excursions, and boys' encampments, is rapidly extending to all parts of the country. A description of such work, by Mr. F. W. Howe, of this Office, is given below.

School-garden work in cities and towns has continued with encouraging results. The most recent available report of the Massachusetts Horticultural Society (1907) showed 49 entries for children's garden prizes offered by that society.

In Porto Rico an act of the legislative assembly approved March 11, 1909, appropriated \$3,000 "to assist the Agricultural Institute of Arts and Trades at Lajas in its work of affording an education to students of agriculture and other subjects studied in the same," provided the department of education organizes and supervises instruction in the subjects included in the common-school course. This instruction is to be free to students regularly enrolled in the institute and also to other children residing in the vicinity who may be legally enrolled in the public schools of Porto Rico. Of the appropriation, \$2,000 is to be expended for improvements in the shops and for agricultural implements and \$1,000 for the maintenance of poor children dwelling in the buildings of the institute.

BOYS' AND GIRLS' AGRICULTURAL CLUBS.

The interest in this form of school-extension work continues to grow throughout the country. Corn growing for boys and bread-making and sewing for girls are the basis for most of the competitive contests, but in some States other lines of effort are specially encouraged, such as cotton growing, potato growing, fruit growing, and poultry and live-stock study. The annual reports of superintendents of education, notably those of O. J. Kern, Winnebago County, Ill., and of State Superintendent E. C. Bishop, of Nebraska, give special attention to this work. Page County, Iowa, and Berks County, Pa., may also be mentioned as typical of the interest this form of school-extension work is receiving. As one result of the work of Superintendent V. L. Roy in promoting club organization in Avoyelles Parish, La., he was appointed to the chair of agricultural education in the State agricultural college, and such work is now to be generally organized throughout the State.

Another indication of such interest is found in the issue of bulletins of information on the subject from state superintendents and agricultural extension departments, such as the one entitled "A Corn Primer," by C. S. Knight, issued in the Teachers' and Pupils' Series of the Kansas Agricultural College, and the "Boys' Corn-Growing Contest," by S. M. Jordan, published by the Missouri board of agriculture. These contests frequently culminate in a "farmers' week" gathering, at the State agricultural college, such as that held at Cornell University, February 22-27, 1909, in which exhibits from 28 boys' and girls' clubs were shown, accompanied by 150 drawings, 150 essays on "How to grow corn," and 200 letters on "How we celebrated corn day in our school."

These state contests are sometimes concentrated at the annual state fair, and include not only awards for club exhibits by school pupils, but also for contests in the judging of such exhibits. The last Iowa state fair offered prizes ranging from \$25 to \$200 for boys in competitive corn judging and from \$25 to \$100 to girls offering the best prepared food products, with reasons for the work done. A variation from this plan is followed by the Colorado state fair authorities in offering a scholarship worth \$125 in any of the regular courses at the state agricultural college to the boy doing the best work in judging live stock and corn and a scholarship worth \$100 in any college or university in Colorado to the girl showing the best work in the preparation of certain foods and giving reasons for the methods used.

Still another outgrowth of this interest is the organization of summer encampments combined with a "corn show," and careful instruction in the breeding and cultivation of corn. Such a "farm boys' encampment" at Glenview farm, Mo., is described by S. M. Jordan

in a bulletin of the Missouri board of agriculture. The "vacation farm school" proposed by Principal B. J. Horchem, of the Audubon School, Dubuque, Iowa, is a modification of this plan providing for the educational employment of town boys based on agricultural work and study.

The general extent of this interest in junior agricultural club work is indicated by the fact that it is thoroughly organized in at least 395 counties in the United States, with a membership of more than 150,000. In the Southern States alone more than 10,000 boys were enrolled in competitive club corn contests in connection with what is known as the boys' demonstration work of this department, and an aggregate of \$10,000 was contributed as prizes to be awarded in club contests in these States.

A COURSE IN NATURE STUDY AND AGRICULTURE FOR ELEMENTARY SCHOOLS.

The New York State Education Department has recently published a course in nature study and agriculture for the elementary schools of that State in 1909-10, which combines in such an admirable way the various features of plant and animal work for the different grades that it is given herewith in full:

BIRDS.

Bird for detailed study: English sparrow.

DIRECTIONS.—Begin the work late in the fall after the birds have molted, base it upon actual observations of live birds. These observations form the material for a comparative study of the winter birds and of the spring migrants as they arrive.

Grades 1-3.	Grades 4-6.	Grades 7-8.
<p>I. Study: Size, color, shape.</p> <ol style="list-style-type: none"> 1. Parts of body: Head, back, tail, breast, belly, wings; and the color and markings of feathers on these several parts. 2. Flight. 3. Song or calls. 4. Nests and care of young. 	<p>I. Study: The work given for grades 1-3; and also—</p> <ol style="list-style-type: none"> 5. More detailed study of parts and markings; add wing coverts and tail coverts, names of common bird colors and uses of colors. <p>Review these topics, basing observations on the hen. Add such as are necessary to complete the life history.</p> <ol style="list-style-type: none"> 6. Structure and use of feathers. 7. Adaptation of bill and feet. 8. Kinds of food. 	<p>I. Study: The work of all preceding grades; and also—</p> <ol style="list-style-type: none"> 9. Value of English sparrow as (a) a destroyer of weeds; (b) a scavenger in towns and cities. 10. Damage done by this bird. <p>Review the hen, distinguish meat and egg breeds; and add—</p> <ol style="list-style-type: none"> (1) Care of hen (a) food; (b) housing; (c) incubation. (2) Value of hen (a) as food; (b) eggs as a crop; (c) market.
<p>II. Birds to be recognized: Any two kinds of winter birds and any five of the following: Canary, song sparrow, robin, bluebird, duck, goose, heron.</p> <p>Tell how these birds resemble and how they differ from the English sparrow.</p> <p>Bird calendars—memorandum of date of arrival, nesting, and other facts of interest.</p>	<p>II. Study: The work given for grades 1-3; and also—</p> <p>Classify according to habitat, as birds of the dooryard, orchard, field, thicket, forest, or swamp.</p>	<p>II. Study: The work of all preceding grades; and also—</p> <p>Food of birds to determine their economic value to farmer, fruit grower, and residents of towns and cities.</p>

III. Poems, stories, and pictures: Bryant's The Song Sparrow; Longfellow's Birds of Killingworth.

ANIMALS.

Animal for detailed study: The dog.

DIRECTIONS.—This work on animals can be taken up at any season, but generally it will be found more satisfactory to begin it early in the year and carry it along with the study of birds.

Grades 1-3.	Grades 4-6.	Grades 7-8.
<p>I. Study: Color, size, shape.</p> <ol style="list-style-type: none"> 1. Parts of body and covering. 2. Food. 3. Uses. 4. Care of young. 	<p>I. Study: The work given for grades 1-3; and also—</p> <ol style="list-style-type: none"> 5. Study of (a) the teeth and (b) the feet, with special emphasis on adaptation to needs of the animal. 6. The dog as a companion of man. <p>Review these topics, basing observation on the cow, and add—</p> <ol style="list-style-type: none"> (1) How the cow bites, chews, and digests food. 	<p>I. Study: The work of all preceding grades; and also—</p> <ol style="list-style-type: none"> 7. Value of dog as (a) protector; (b) destroyer of vermin; (c) special use in north lands. 8. Losses from dogs. <p>Review the cow, distinguish beef and dairy types; and add—</p> <ol style="list-style-type: none"> (2) Care of cow (a) food, balanced ration, (b) housing, need of sanitary conditions. (3) Beef products. (4) Dairy products: (a) milk, clean, certified, pasteurized; (b) butter and cheese, Babcock test. <p>(The Babcock test is optional, but it is recommended when the apparatus can be secured.)</p> <ol style="list-style-type: none"> (5) Geography—where beef and dairy products are produced and where marketed.
<p>II. Animals to be recognized: Cat, mouse, horse, rabbit, squirrel. Tell how these animals resemble and how they differ from the dog.</p>	<p>II. Study: The work given for grades 1-3; and also—</p> <ol style="list-style-type: none"> 1. Adaptation to different seasons. 2. Classification as useful or harmful to man. 	<p>II. Study: The work of all preceding grades; and also—</p> <ol style="list-style-type: none"> 3. More detailed study of economic values. 4. Eradication of such as are pests.

III. Poems, stories, and pictures: Emerson's Mountain and Squirrel, Phoebe Cary's That Calf, Scott's Helvellyn, Brown's Rab and his Friends, Ouida's Dog of Flanders; picture—Douglas's Mother and Daughter.

NOTE.—Owing to the economic value of the cow, this animal is introduced in the fourth grade, as the hen is in the study of birds.

PLANTS.

Plant for detailed study: The pea.

DIRECTIONS.—About March 15 plant in pots of loam, sand, and sawdust; also in lantern chimney lined with blotters to show germination.

Grades 1-3.	Grades 4-6.	Grades 7-8.
<p>I. Study:</p> <ol style="list-style-type: none"> 1. Parts of seed, storage of food for the little plants. 2. The plant (a) color, size, shape; (b) parts—root, stem, leaf, flower; (c) where it lives. 	<p>I. Study: The work given for grades 1-3; and also—</p> <ol style="list-style-type: none"> 3. Parts of flowers and their uses. 4. The fruit—peas in the pod. 5. Review life history of pea; seed, seedling, root, stem, leaves, flower, fruit. 6. More careful study of method of growth, roots, and root hairs. 7. How the plant gets up to the sunlight—use of tendrils. 	<p>I. Study: The work of all preceding grades; and also—</p> <ol style="list-style-type: none"> 8. Needs of the plant in growing—moisture, warmth, and air, sunlight, soil. Here study texture of the soil and its relation to plant growth. 9. Value of the pea (a) as food for man, for stock; (b) market for food, canning; (c) as a fertilizer, a legume.
<p>II. Plants to be recognized: One of the clovers, one of the grasses, one of the grains, and any six of the following—geranium, hepatica, strawberry, apple, golden rod, blue, columbine, lettuce, onion, bloodroot.</p> <p>Tell how these resemble the plant—pea.</p> <p>Plant calendars—memorandum of date when the plants are first seen in blossom and other facts of interest.</p>	<p>II. Study: The work given for grades 1-3; and also—</p> <p>Weeds: 1. When is a plant a weed?</p> <p>2. Identification of five plants that are commonly weeds: Canada thistle, wild mustard, orange, hawkweed ("paint brush"), wild carrot, long-leaved plantain.</p>	<p>II. Study: The work of all the preceding grades; and also—</p> <p>3. Life history of the weeds—root structure and seed dispersal with a view to learning how to destroy them.</p>
<p>III. Poems, stories, and pictures suggested: Bryant's Gladness of Nature, The Planting of the Apple Tree.</p>		



THE FARMERS' INSTITUTES IN THE UNITED STATES, 1909.

By JOHN HAMILTON, *Specialist*,
and

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During the past year farmers' institutes were conducted in all of the States excepting Louisiana and Nevada and in all of the Territories excepting Alaska and Hawaii, where, although an attempt has been made to inaugurate this movement, no regularly organized farmers' institutes were held.

INSTITUTES HELD.

Reports have been received from 49 States and Territories, and in 47 of these institutes were held. Marked progress has been made this year in institute activity in all directions over any previous year; more money has been appropriated for farmers' institute work, more sessions have been held, and the total attendance has been larger than at any time since this means of carrying agricultural information to the actual farmers themselves has been in vogue.

The number of institutes held during 1909 as reported by 47 States and Territories is 5,014, while in 1908 the reports from 45 States and Territories gave the number as 4,643. In 1909 the reports from 43 States and Territories gave the total number of institutes as 4,714, and in 1908 these same States and Territories reported 4,517 institutes, which was a larger number than in any previous year. The year 1909, therefore, shows an increase of 197 over the highest previous record.

In 1908, 43 States and Territories gave the number of one-day institutes held at 2,704, two-day institutes at 1,753, and three-day institutes at 96, while in 1909 these same States and Territories report 2,844 one-day institutes, 1,726 two-day institutes, and 144 three-day institutes. This shows an increase in 1909 of 140 one-day institutes and 48 three-day institutes, and a decrease of 27 two-day institutes. The total number of days of institutes held in 1909 is reported by 47 States and Territories at 7,134 and in 1908 by 45 States and Territories at 6,647. In 43 States and Territories the number of days of institutes held during 1909 is reported at 6,728, and in 1908 these same States and Territories reported 6,498 days of institutes.

SESSIONS.

The number of sessions held during 1909 is reported by 47 States and Territories at 15,535, and in 1908 it was reported by 45 States and Territories at 14,934. In the 43 States and Territories reporting both years the number of sessions held in 1909 is given at 14,732, and in 1908 at 14,640, thus showing an increase of 92 sessions held during 1909 over the past or any previous year. Since the session is regarded as the unit for estimating institute work and progress, the increase of 92 sessions held during 1909 over that of any previous year is indicative of substantial growth and progress.

ATTENDANCE.

The 47 States and Territories reporting give the total attendance in 1909 at 2,240,925. In 1908 the number reported by 45 States and Territories was 2,098,268, an increase in 1909 over the previous year of 142,657. A comparison of the same 43 States and Territories that reported both last year and this year shows a total attendance in 1909 of 2,158,915 and in 1908 of 1,693,043, thus making an increase of 465,872 in the total attendance at farmers' institutes in 1909 over last year or any previous year. An increase is also shown in the average number in attendance at a session. The average number of persons attending a session in 1908 was 115, while in 1909 it was 146, an increase of 31 persons at each of the 14,732 sessions.

APPROPRIATIONS FOR INSTITUTES.

Forty-seven States and Territories reporting gave the appropriations for 1909 from all sources at \$345,666.49, while in 1908, 47 States and Territories reported \$325,569.54, an increase of \$20,096.95 for 1909. The 43 States and Territories reporting in both 1909 and 1908 gave the appropriations for 1909 at \$331,466.49, and for 1908 at \$315,209.76, an increase in 1909 over the previous year of \$16,256.73.

COST OF INSTITUTES.

Forty-three States and Territories in 1909 report the total cost of their institutes at \$316,765.86, and these same States and Territories in 1908 reported the total cost at \$289,593.29, an increase in 1909 of \$27,172.57. According to these same reports the average cost per session increased from \$19.77 in 1908 to \$21.51 in 1909.

AGRICULTURAL COLLEGE AND EXPERIMENT STATION AID.

The number of agricultural college and experiment station people engaged in lecturing at farmers' institutes during 1909 was 20 less than in 1908, according to the reports from the same 43 States and

Territories which gave the number as 404 in 1909 and 424 in 1908. This is not as great a reduction as one would expect when increased demand on the time and energy of these people from their own institutions is considered. The total number of days of institutes attended by these college and station staffs in 1909 was 3,041, while in 1908 it was 3,586, according to the same reports. This likewise indicates a further reduction in the help derived from the agricultural college and experiment station staffs as regards lectures by these people before farmers' institutes, and this reduction is still further emphasized when the increase of one hundred and sixty-nine days of institutes held in 1909 over those held in 1908 is considered. It indicates clearly that the demand upon the staffs of the agricultural colleges and experiment stations for increased duties within these institutions themselves is preventing them from devoting as much time to farmers' institute work as its increased demand warrants, but it is hoped that with the establishment of departments of extension work within the agricultural colleges this condition may be remedied to a certain extent. It is evident, however, that the managers of farmers' institutes must in the future look to other sources than the staffs of the agricultural colleges and experiment stations for the increase in their lecture force. Each year adds to the necessity for a more permanent and independent lecture force—a corps of educated, scientific, experienced, and practical farmers, scientists, and other competent speakers and demonstrators whose entire time shall be devoted to institute work as lecturers, demonstrators, itinerant instructors, inspectors, district managers, or to other duties which legitimately come within the scope of farmers' institute work. This plan would not only relieve the colleges, but it would also render the institutes more independent and ultimately give them entire control of the services of a competent body of farmers' institute workers.

SPECIAL INSTITUTES.

A considerable amount of instruction in various agricultural subjects is given to rural people through meetings conducted primarily by the farmers' institute organization and yet not classified as regular farmers' institutes. Such miscellaneous meetings are in many instances doing as much for the improvement of agricultural conditions and rural life as are the regular farmers' institutes, and they form a prominent feature of the institute work in some States.

An idea of the extent and scope of this work may be obtained by the following summary of the reports for the year 1909:

Four States held special-subject institutes; two of them did not give the number, but the other two report a combined number of 36 such meetings. The total attendance in the four States upon these

special-subject institutes was 17,268. Independent institutes were held in 10 States, the total number of meetings being 196 with an attendance of 381,412. Thirteen States report 156 round-up institutes with 39,199 in attendance. Railroad specials were run in 15 States; in 8 of these 594 stops were made, and in the other 7 the number of stops was not reported, but the total attendance as given for the 15 States was 167,387. While in several States women's institutes were held in connection with the regular institutes for men, in 4 States separate and independent women's institutes were conducted with a total of 145 sessions. In 25 sessions the attendance was 4,300, while no report was given of the number in attendance at the other 120 sessions. These separate women's institutes offer a fertile field for future development in the United States where they can scarcely be said to have begun, and yet in Ontario they have already overshadowed the regular men's institutes. While it is known that some 16 States have been conducting boys' and girls' meetings of various kinds, although not usually classed as institutes, nevertheless only one State reported having held regular boys' and girls' institutes during 1909, and the attendance was not given. Here again is another field for fruitful work lying within the scope of the farmers' institutes, and yet one that has not been developed to any considerable extent, although its importance warrants attention. Three States held 8 normal institutes with an attendance of 1,000 in 2 of the States, the other one not reporting the attendance. One farmers' picnic was held in each of 2 States with a total attendance of 2,350. Demonstration meetings were reported from only 1 State which held 2 with an aggregate attendance of 400. Farmers' institute schools were held in 2 States, one holding 3 with 530 in attendance, and the other holding 12 schools but not reporting the number in attendance. One State held an annual convention consisting of 5 sessions and a total attendance of 2,500. One State held movable schools at 13 places lasting six days at which there were 1,415 in attendance.

The total attendance at all of the above 12 forms of special institute activity was 617,954, which added to 2,240,925, the attendance at the regular institutes reported, makes a grand total of 2,858,879 in attendance at all forms of farmers' institutes during 1909. In addition no record has been given of the attendance upon the following forms of institutes: Women's institutes, 117 sessions; boys' and girls' institutes in one State with 14 meetings; and 12 farmers' institute schools. And to all this should also be added the attendance at the regular farmers' institutes in two of the three organizations holding farmers' institutes in Connecticut for which no reports have been received.

EVIDENCES OF PROGRESS.

In Arizona the institute force lectured at the local schools to the children and others, and also gave instruction in agricultural subjects to regular classes for as long a time as possible, thus helping to pave the way for the introduction of agriculture in the public schools.

California last year introduced demonstration train work, covering 2,608 miles during the sixty-four days it was in use. The trains stopped at 197 places, spending from one to five hours at each, and the total attendance is reported to have been 37,270. Three coaches were used exclusively for exhibits illustrating cereal production, soils of the State and fertilizers for the same, creamery and dairy work, economic plants especially adapted to the region such as the eucalyptus, various plant diseases, insect pests, and diseases of animals. The farmers' institute superintendent reports:

We consider that this train service was of great value from an educational point of view. Through this instrumentality we were able to bring directly to the men most interested tangible illustrations of the results obtained through careful and scientific farming. The exhibits carried in the cars were entirely either the product of the university farm and various substations or materials obtained in our experimental work upon different farms through the State. Its educational value can not be overestimated.

In Indiana the farmers' institute is working in close cooperation with the women's auxiliaries through the State with a view to the betterment of the conditions of life of rural women and the elevation of the country home. While very few separate women's institutes and comparatively few separate women's sessions are held, nevertheless the work is assuming good proportions through the women's auxiliaries holding joint sessions with the regular farmers' institutes. Women's auxiliaries are organized in 41 of the 92 counties in the State, and last year 48 women's sessions were held in connection with farmers' institutes in 27 counties, and all of these sessions were under the immediate charge of the women's auxiliaries. Within the past five years 87 of the 92 counties of the State have thus been visited at least once by a trained instructor in domestic science covering the subject relative to foods and the home. Many of these women's auxiliaries are thus doing a vast amount of good among rural women by interesting them in labor-saving devices, conveniences, and better sanitary conditions, as well as in better methods of preparing and preserving foods, caring for the sick, and beautifying the home. They have in some cases offered prizes for culinary exhibits at the farmers' institute, and have in this way aroused the interest of the girls.

Maryland has conducted institute schools and short courses of six lectures each in various parts of the State, using an especially con-

structed and equipped car owned privately by the institute. This is the first instance where a car has been planned, built, and owned by an institute for the sole purpose of giving itinerant instruction and demonstrations. It is in reality a small but completely equipped school capable of being taken to the people, and in which the instructors live, eat, and sleep, but from which they may go within driving distances for the purpose of holding meetings or giving lectures whenever advisable. Many cars and even trains have been used temporarily in various States for institute work, but they have been owned and controlled by the railroads and were not especially constructed for this purpose, ordinary coaches being temporarily fitted up with the necessary illustrative and demonstrative material.

Michigan held 40 women's institutes last year, and the superintendent reports: "The attendance and interest often were better than at the general session." They are also making a special effort to arouse the interest of the young people.

In Minnesota the boys' and girls' industrial contests, which have just finished their second year's work, were so successful that the superintendent of institutes for the State reports: "We have done no work that we feel will result in more good to the agriculture of this State than will this work done with the boys and girls." Excellent results are also reported from the organization of district or township clubs, most of which become active and productive of much good to the members.

The Mississippi farmers' institute gets in touch with the county high schools as fast as they are established, and through cooperation conducts short courses in agriculture.

IMPROVED METHODS.

In Arkansas the farmers' institute work has been placed entirely in the hands of the agricultural college, which has established a department of farmers' institutes with a superintendent in charge.

California has developed the special or single-purpose institute idea, an entire meeting being devoted to the discussion of a single topic in all its phases and from all points of view, thus approaching the plan of some of the movable schools which are devoted to a single subject, such as dairying, poultry raising, and the like, but being from necessity more intensive since the duration of the institute is not as long as that of the movable school. In reporting upon this work the superintendent says: "We find that the attendance and interest at these meetings is as great or greater than when the institutes are very general in their character." These special-purpose institutes should prove of great value in those States where the regular general institutes have been in progress for some time, and where many of

the farmers feel that they have graduated, so to speak, from the necessarily elementary character of the instruction given in them. These special-purpose institutes can, by devoting the entire meeting to a single subject, go deeper into the matter and present the whys and wherefores and the scientific principles underlying them which are of vast interest to the farmer, but which can not be gone into in the short time devoted to a single subject in the regular general institutes. They give an insight into the theories and a better understanding and appreciation of the work under discussion, and thus arouse an enthusiasm and love for agricultural work which helps to elevate this vocation to that of a profession and an art, and to build up a higher plane of rural life. The regular general institutes should not be relinquished, for they will always have their field of usefulness, but the special or single-purpose institutes should be developed and extended in those States where institute work has been in active and extensive progress for a number of years, and especially in those locations where there is a pronounced tendency toward specialization of production.

Colorado has developed its short-course institute work to the extent of producing what might be termed movable schools. The success attending this work can be judged from the report of the superintendent of farmers' institutes, who says: "The most valuable and the best appreciated work that we have done is in holding six-day farmers' short courses and five-day housekeepers' short courses in various parts of the State."

The Georgia farmers' institute held last year teachers' institutes in cooperation with the county school commissioners. The director of farmers' institutes says of this work:

The teachers' institute movement has been an unqualified success and promises to grow rapidly in the future with benign results to both adults and the boys and girls. We are more than gratified at the reception given our lecturers, and have been unable to meet the demand made upon us for assistance. We hope to stress this work more than ever another year, as it seems to us to promise as large dividends as any feature of the institute work we have had experience with. We have made a start on itinerant schools in connection with our institute service, which promises well.

Indiana holds each year in October, just before the opening of the institute season, a normal institute and also a conference of institute workers. All the farmers' institute speakers assigned for work that year are required to attend both these meetings. The county chairmen are expected to attend in person or to send substitutes to the conference, and the presidents of women's auxiliaries are invited to the conference.

In Minnesota one twelve and one eight weeks agricultural lecture course was held at the high school in each of two towns. The lectures and discussions lasting for two hours were given Monday afternoons,

at which time the school was dismissed for the purpose, and the boys and from 30 to 50 farmers assembled in one room, and the girls and women in another room for instruction in home economics. The lectures and discussions lasted two hours. Each farmer paid a small fee to defray traveling expenses of lecturers. These two courses proved to be very successful.

West Virginia: An approach to the county itinerant instructor found in several foreign countries, and which for many years has proven of such value to the agricultural interests, among the small holders especially, has been inaugurated in West Virginia, where a special field man was last season employed by the year whose duty it was to go over the State among the farmers and hold special institute meetings wherever and whenever he could get a few of them together. This method of reaching certain farmers should prove of value in the more thickly settled regions, especially where small farms are the rule.

AGRICULTURAL COLLEGE EXTENSION WORK.

The establishment of colleges of agriculture and more especially the creation later of experiment stations in connection with them stimulated the demand for the acquisition of new, accurate, and specific information regarding all classes of agricultural subjects and operations based on a scientific study of the principles underlying the various sciences bearing on agriculture. This search after new truth was not only productive of much good to agriculture in all its phases, but also many new sciences such as mycology, entomology, vegetable pathology and the like were largely developed out of the divisions of older ones through their immediate application to agriculture. Every science and art having directly or indirectly an economic bearing on agriculture received an impulse and a stimulus, accurate scientific experiments were carried on in many lines, great and rapid strides were made in all directions, exceeding the most sanguine expectations. The great demand was for "research"—the acquisition of more truth and information regarding all agricultural subjects.

But the time has now arrived when it is apparent that the vast store of agricultural information thus accumulated and rapidly being added to is not fully reaching the people for whom it is intended—the actual farmers. The colleges of agriculture, through the students who enter their doors, are imparting this information to but a very small percentage of the agricultural people. The vast army of actual farmers for whom this information is intended can not attend college at all—not even for a few weeks short course in the winter.

The publishing and distributing of circulars, bulletins, reports, and the like, dealing with agricultural subjects and giving the latest

results of research helps greatly in disseminating this information, but it does not reach the larger percentage of those actually engaged in agriculture. As a rule, it helps only those educated, well-informed, and progressive farmers and does not reach the ones most needing it. In order therefore to carry the vast store of accumulated agricultural information to the majority of farmers it is necessary to resort to some form of educational extension work.

The actual farmers can not go to the colleges of agriculture, but the colleges of agriculture must be taken to the farmers. When this is accomplished the result will be a complete agricultural education, but one which could not have been possible without research first. Agriculture will then become a profession.

Agricultural education extension work has been carried on for a number of years in a small way, usually independent of the colleges of agriculture or at most cooperating with them, yet a sufficient amount of this work has been done to pave the way and to demonstrate the methods to be pursued in a complete agricultural education extension system. The Association of American Agricultural Colleges and Experiment Stations at its meeting held in Portland, Oreg., August 18 to 20, 1909, changed its constitution and created a section on agricultural education extension work so that the association now consists of three sections—a section on colleges, a section on experiment stations, and a section on agricultural education extension. Thus the work under discussion has been officially recognized as on a par with the other two forces at work for the agricultural interests of the United States.

THE AMERICAN ASSOCIATION OF FARMERS' INSTITUTE WORKERS.

The Fourteenth Annual Convention of the American Association of Farmers' Institute Workers, held in Portland, Oreg., August 16 and 17, 1909, was attended by 99 delegates from the United States and 4 from the Canadian Provinces.

The usual standing committees made their reports, showing the condition and progress of the several branches of the work, and made suggestions and recommendations for their betterment. The papers read and discussed dealt with the general policy of the institute movement, the character, scope, and status of its various ramifications and relations, the progress made, and the methods and means used in the several States, Territories, and Provinces for accomplishing the desired results. Methods of work for the improvement, development, and expansion of the institute movement were ably presented.

Some of the points brought out were: That while the institutes should continue to give general elementary instruction, they should also develop to an increasing extent the movable school idea of giving more definite, specific, and extended instruction along certain lines; that the woman's institute should receive vastly more attention; that the boys' and girls' institutes or sessions should be started in all the more thickly populated States if only in the form of competitions; that local people should be more freely consulted and should bear a share in the expense; and that demonstration work should be encouraged.

Reports from the Canadian Provinces of Alberta, British Columbia, Manitoba, Nova Scotia, Ontario, Quebec, and Saskatchewan were presented showing that they held 7,154 sessions of institutes last year with an attendance of 300,888.

INSTITUTES FOR WOMEN.

Institute directors are coming to appreciate the fact that if institutes for men have been valuable through the dissemination among them of information adapted to their special needs there is no reason why they should not be equally successful if their efforts were directed particularly to the improvement of women's life and work. According to the census there were in all 37,244,145 women and girls in this country in 1900. About 35 per cent of these, or over 13,000,000, live in rural districts.

As yet no comprehensive system has been put in operation by which the State shall be responsible for supplying educational facilities specially designed for reaching country women at their homes. While the farmers' institute has done something in this respect, yet until quite recently its efforts have been chiefly in the direction of assisting men, leaving the women to depend upon themselves, or at most to gather what they can from the teaching which the men receive. It manifestly is not meeting country needs when the education furnished is adapted to the needs of the male population only, for that assumes that the problems of country living all lie outside of the walls of the house in which the family dwells. Instruction helpful and adapted to the needs of country women should be provided as well, in order that their influence, whether exerted in school or church, the social circle, or in domestic life, shall be most beneficial to the family and the State.

It is certainly worth while to make an effort to reach country women with helpful information, and a proper proportion of the money appropriated for institute purposes by the State should be devoted to this purpose. This Department has recently published a

circular ^a upon this subject in which there are outlined some methods that might be employed in organizing women's institutes and in providing for their support.

THE ANNUAL REPORT OF THE STATE DIRECTORS.

As the institute work develops the annual reports of the state directors become more important. When the work began there was but a single form of institute activity, consequently a simple statement of the number of meetings held, the attendance, and the speakers present was all that seemed to be required. Later poultry, dairy, fruit, market gardening, and similar forms of special institutes were held; the women's institute has been introduced; boys' and girls' contests, the movable school, the demonstration plat, the railroad special, and other features have been added until there are now in use numerous branches of institute activity each rapidly expanding to include a larger field and many more persons within its influence.

As the work progresses the importance of having exact information respecting it is correspondingly increased. Each state director in order that he may intelligently direct its operations is interested first of all in securing accurate data respecting the progress of the work in his own State, and second he is interested in knowing what is being done by institute directors in other States that he may profit by their experience. These data in order to be serviceable must be accurate. To secure such information and to get it promptly, each director is under the necessity of thoroughly organizing his work and of preparing and issuing blanks to be filled in with the proper data. This requires that he shall have one or more capable persons present at each institute meeting to obtain the information and forward it to the central office.

Most of the institute directors appreciate the importance of full and accurate information and have organizations of more or less efficiency for securing it. A few, however, are still neglectful in this respect, and consequently are in comparative ignorance of the details of their work, so that when called upon for information respecting it they are compelled to resort to estimates with but little that is reliable upon which to base their judgment.

An inspection also of the annual reports published in the several States shows that quite a number are chiefly made up of papers by institute lecturers and lists of questions and answers, and of the names and subjects of discussion. In a few instances only a paragraph or two in relation to the institute work is published, and in others the report consists of a bare recital of statistical facts, with

^a U. S. Dept. Agr., Office Expt. Stas. Circ. 85.

no discussion of the work or statement of projects for its development. While these are all valuable in their place, their value would be greatly increased if the items referred to were accompanied by a thoughtful discussion of their principal features by the director, followed by a general summary of the progress of the institute work as a whole.

The state director, if interested in his work, is constantly studying to improve his methods. A complete statement, therefore, each year of his views as they are enlarged or modified by his study and experience, accompanied with the reasons for his present attitude, would often be of great service to directors in charge of institutes in other States, as well as to lecturers and local managers generally throughout the country.

MONTHLY MEETINGS.

A feature of the institute work most open to criticism is the short period that is given to instruction in a locality in any single year. One or two days is the usual allotment, and in this period a topic may be presented by only a single speaker, to be frequently passed without further discussion. It is manifest that by this method the institute will be many years in educating the farmers in a community in the principles of agricultural science and practice. Under the present method of institute management the individual in a State is apt to be lost sight of in the general mass or volume of work accomplished. Institute directors and lecturers are liable to be misled into thinking that they are doing a great deal for the individual man when they are busy for several months teaching in institute meetings. The work in the aggregate is very considerable, and is of good quality, but it ordinarily touches a single individual for only a day or two at most and comparatively few are reached at all.

The institute lecturer after three or five months' campaign may profitably inquire what he has done in this time in educating any single individual. The state director also at the close of the institute season might inquire to what extent any one individual has been benefited by the expenditure of ten, twenty, or thirty thousand dollars appropriated by the State. Instruction has been furnished for him for two days, possibly for only one. How long will it take by this method to reach, even with a day's instruction, all of the agricultural people of the State? These queries will necessarily develop the fact that the institute can never as at present organized accomplish that which manifestly is its chief purpose, namely, reaching every individual farmer with information sufficient to render him proficient in his business. This requires that the individual must be instructed through a longer period each year than the institute provides, and

that the instruction shall be so directly related to his occupation as to be of positive aid in increasing his productive power.

An experiment in this direction has been under way in Kansas under the direction of the superintendent of institutes of that State which appears, partially at least, to have solved the problem of more and better instruction every year. The plan consists in holding each month in the year and upon the same day of the month one institute in each county, with the same topic for discussion, the places to be selected by the local committee in the county. At the beginning of the year a list of 12 topics, one for each month, is forwarded by the state director to the local managers to be discussed the same day in every county throughout the State.

If the time were fixed for the fourth Friday in each month, and the month were January, and the topic the rearing of poultry, this subject would be discussed all over the State on the fourth Friday of that month. Similar topics suited to the agricultural operations of the season would be assigned for every other month, and thus the institute would be active in aid of agriculture in every county in the State during the entire year. By publishing the list of topics in advance full opportunity would be given to prepare for the discussion of the subjects to be taken up each month.

This does not supplant the present form of institute, but supplements it and extends its influence by taking advantage of the impulse which the regular institutes with their corps of state speakers furnish to keep the others active through the season.

In making up a list of subjects state directors should consult the county managers, and suitable topics be agreed upon for the succeeding year. The monthly institutes would be managed and carried on by local people, and if found advantageous and sufficiently popular could be held more frequently than once a month.

By this means important subjects may be brought to the attention of all of the farmers of a State upon a given date, the subject would be thoroughly discussed both in the institutes and in the homes of the people, and the enthusiasm occasioned by its universal discussion would tend to stimulate many to put the recommendations into practice.

This plan has many advantages. It will organize institute work throughout the State, and extend its benefits to small outlying localities where the regular meetings are rarely held. It will develop local men and women who without it have little opportunity to serve their neighbors by relating their experience obtained after many years of successful farming. It will encourage and stimulate the reading habit among the members of the institute, and enable the national and state departments of agriculture and the experiment stations to send bulletins where they will be of direct benefit in increasing production and in improving rural life.

WORK OF THE OFFICE.

The work of the office of the institute specialist during the year has been chiefly in the direction of endeavoring through correspondence and personal visitation to secure the introduction of the methods for institute improvement and of other forms of extension work that have been recommended in previous years. In pursuance of this effort, visits were made to institute officials in the following States and Territories: Alabama, Arizona, California, Georgia, Idaho, Louisiana, Minnesota, Mississippi, Montana, New Mexico, Oregon, Pennsylvania, South Carolina, and Washington.

An exhibit composed of statistical charts giving information respecting the farmers' institute work of the United States was prepared for the Alaska-Yukon-Pacific Exposition. The office has edited and published the annual report of the American Association of Farmers' Institute Workers; has revised the list of Farmers' Institute Directors and Lecturers; and has collected and published data showing the condition of the farmers' institute work in the several States and Territories for the annual report of the Office of Experiment Stations. A circular on Farmers' Institutes for Women has also been published; the manuscript copy and photographs of an illustrated lecture upon wheat culture have been sent in for publication, and other lectures of similar character are in preparation.

Statistics and other informational data have been gathered for the use of the standing committee of the Association of American Agricultural Colleges and Experiment Stations on extension work.

STATE REPORTS.

Numerous items of interest in the reports of the state directors are incapable of tabulation or are peculiar to a particular State, and at the same time are important to a complete record and understanding of the progress of the institute work as it develops each year. In order that the great body of institute workers may be familiar with this progress, the principal points are incorporated in the following accounts under the respective names of the States and Territories.

ALABAMA.

Institute director.—C. A. Cary, professor of veterinary science, Alabama Polytechnic Institute, Auburn.

The State did not make a direct appropriation for institute work, but the Alabama Polytechnic Institute appropriated \$600 for the work, besides giving the time of the director and twelve members of the college and experiment station staff, which it is reported would add \$800 to the amount of money appropriated. "Get ready for the coming of the boll weevil" was one of the subjects discussed at every

meeting. The director arranges for the places, dates, and programmes of the institutes. There were held during the year 42 sessions of institutes, with 4,240 in attendance.

ALASKA.

Institute director.—C. C. Georgeson, special agent in charge of agricultural experiment station, Sitka.

No report was received from the agent in charge, but it has been learned from other sources that one institute was held with satisfactory results.

ARIZONA.

Institute director.—R. W. Clothier, professor of agriculture, College of Agriculture, Tucson.

During the year 34 sessions of institutes were held, at which 1,862 were in attendance. The State appropriated \$123.95 for the work, and the college and experiment station furnished the speakers, four in number. The Mormon Church took charge of the institutes in the Gila Valley, where most of them were held, and the speakers lectured at the schools to the children and others who came in. The State has recently made a more liberal appropriation for institutes, so that better and more work will be accomplished next year, and the short-course feature again resumed. The superintendent consults with local authorities regarding the dates and programmes for the meetings.

ARKANSAS.

Institute director.—Geo. A. Cole, superintendent of farmers' institutes, College of Agriculture, Fayetteville.

The State has recently placed the farmers' institute work in the hands of the college of agriculture, which has organized a department for this purpose and appointed a superintendent.

The number of sessions of regular institutes held the past year was 150 and the total attendance 2,101. In addition there were 3 institutes held at fairs at which the total attendance of 42,060 is reported. The State appropriated \$2,135.60 for institutes, and the college and experiment station contributed the time of the director and 12 lecturers, which is estimated to have been worth \$2,500 additional. The director arranges the programmes, dates, and location of the institutes.

CALIFORNIA.

Institute director.—W. T. Clarke, professor of horticulture, College of Agriculture, Berkeley.

There were 250 sessions of institutes held during the year, with an attendance of 28,294, at a cost of \$6,000 to the State and \$1,000 to

the college. An appropriation of \$10,000 per annum for the next two years will enable the institutes to be held in some of the counties of the State not yet receiving such attention. Ten members of the agricultural college and experiment station staff attended in all one hundred and eight days of institutes. Eight sessions of special institutes were held, with a total attendance of 2,928. A fully equipped demonstration train was run a total of sixty-four days, covering 2,608 miles and making 197 stops, with an aggregate attendance of 37,270. Institutes were held throughout the entire year in order to accommodate those living in regions which differ from one another in regard to the time of the leisure and busy seasons, due to local climatic conditions.

COLORADO.

Institute director.—H. M. Cottrell, superintendent of farmers' institutes and college extension work, College of Agriculture, Fort Collins.

The superintendent of institutes fixes the dates and places of the meetings and arranges the programme. During the year 130 regular sessions were held and the attendance was 22,560. In addition, a potato special train was run, with an attendance of 1,925. The expense of the institutes amounted to \$9,242.42, of which \$5,000 was state appropriation and \$4,242.42 fees derived from short courses. The agricultural college and experiment station furnished 22 lecturers. Attention has already been called to the success attending the six-day farmers' short courses and the five-day housekeepers' short courses which were conducted last season.

CONNECTICUT.

Institute director.—J. G. Schwink, jr., secretary Dairymen's Association, Meriden.

A new feature of the work this year was the offer of \$100 in prizes to those starting to keep individual milk records of their herds for one year.

During the past year the state dairymen's association conducted 53 sessions of farmers' institutes, with an attendance of 4,600, at a cost of \$631.97, nearly all of which was appropriated by the State, the remainder coming from membership fees and other sources. Besides the above the association gave \$594 in premiums at the annual convention for butter, cheese, milk, and cream. In addition there were 2,500 in attendance at the annual convention of 5 sessions. Eight members of the agricultural college and experiment station lectured at the meetings and institutes. The secretary of the association arranges the programmes and fixes the dates and places of the meetings.

DELAWARE.

Institute director.—Wesley Webb, secretary state board of agriculture, Dover.

Agricultural education was a subject discussed at all the meetings during the past season, and lectures on the home were given at most of the meetings. The grange, as well as the experiment station, is actively cooperating in the institute movement, and as a result the interest in the work is reported as becoming more intense and deepening very rapidly.

Seventy sessions of institutes were held during the past year, with a total attendance of 9,210 and at a cost of \$900, all of which was appropriated by the State, but \$300 of which was accumulated money. The above amount, however, does not include the salary and expenses of the director. Four members of the agricultural experiment station staff devoted twenty-three days' service to the institute work. A farmers' day was held at the agricultural college on June 14. The county institutes are consulted in regard to the programmes, dates, and places of the meetings.

FLORIDA.

Institute director.—P. H. Rolfs, director of the experiment station, Gainesville.

During the past year there were held 56 sessions of institutes with a total attendance of 5,576. The State appropriated \$2,500 for this work, but the cost of the institutes held is reported at \$2,000. An appropriation of \$7,500 has been made by the State for farmers' institute work for 1910. The college of agriculture furnished 1 speaker and the experiment station 6 speakers, while 10 state lecturers were employed, and 23 local speakers addressed the meetings.

GEORGIA.

Institute director.—A. M. Soule, president of the agricultural college, Athens.

Agricultural education was a topic discussed in all the institutes. A new feature of the work in Georgia was the holding of joint farmers' institutes and teachers' institutes in cooperation with the county school commissioners.

Fifty-six sessions of regular institutes were held the past year with an attendance of 4,480. There were also held 16 independent institutes with 2,400 in attendance, 15 sessions of round-up institutes at which 600 were reported, and 60 teachers' institutes and 44 miscellaneous meetings, with a total attendance of 9,850. All this is reported to have added greatly to the general interest in agricultural education in the rural schools. The State appropriated \$2,500 for institutes, but the work cost \$7,000, the college and station contributing the difference in time and service of lecturers and the director. The local authorities are consulted regarding the pro-

grammes, dates, and places of the meetings. There are state senatorial organizations with officers in each county. Ten members of the agricultural college and two of the experiment station staff lectured at these institutes.

HAWAII.

Institute director.—William Weinrich, jr., secretary and treasurer farmers' institutes, Honolulu.

No report was received.

IDAHO.

Institute director.—E. E. Elliott, acting dean of the college and acting director of the agricultural experiment station, Moscow.

The number of sessions of institutes held the past year was 90 and the total attendance was 8,560. A railroad special also made 30 points at which institutes were held, with 5,590 in attendance. The subject of dairying was discussed at all the meetings. The State made an appropriation of \$1,000 for the institute work last year, all of which was used for paying traveling expenses, the other expenses being met out of the general maintenance fund of the college of agriculture, which, together with the experiment station, furnished 7 lecturers for the meetings.

ILLINOIS.

Institute director.—F. H. Hall, superintendent of farmers' institutes, Aurora.

The county farmers' institutes in Illinois are semi-independent organizations, but are in close touch with the state organization. The law requires each county institute organization to hold at least one meeting of two days' duration each year in order to receive the annual state appropriation of \$75, which is audited and in charge of the state organization. The state organization is now going to put a special man in the field whose duty it will be to assist the county farmers' institute officers in every way.

Farmers' institutes were held last year in every county in the State except one. There were in all 659 sessions and the attendance was 82,855. Nine sessions of round-up institutes drew an attendance of approximately 5,000. The State appropriated \$15,000 for institute work. Of this amount \$8,500 was used for the expenses of the state institute and \$75, or so much thereof as necessary, was given to each county. The superintendent and the county officers in conference make all arrangements regarding the institutes.

INDIANA.

Institute director.—W. C. Latta, professor of agriculture, College of Agriculture, Lafayette.

A normal institute and a conference of institute workers at which all assigned speakers are required to attend is held before the opening

of the institute season, and county chairmen are expected to attend the conference, or at least to send a delegate.

There were held last year 1,162 sessions of farmers' institutes, and the total attendance was 215,211. The approximate cost was \$20,000, of which \$10,000 was direct state appropriation, and the remainder made up from private donations and membership dues from the county organizations, amounting to \$6,800, and that received from the county treasurer, amounting to \$3,200. Each county contributes \$100 for institutes, provided an equal amount is raised from membership dues. The college of agriculture provided six and the experiment station five lecturers for the institutes.

IOWA.

Institute director.—J. C. Simpson, secretary state board of agriculture, Des Moines.

The extension department of the college of agriculture cooperates with the state board of agriculture and furnishes lecturers.

Four hundred and fifteen sessions of institutes were held during the year, with 103,750 as the total attendance. The total cost of these meetings was \$10,050.58. The State appropriated \$6,030.51, and the donations and membership fees amounted to \$4,020.07 more.

KANSAS.

Institute director.—J. H. Miller, superintendent of farmers' institutes and agricultural extension, college of agriculture, Manhattan.

The farmers' institutes are entirely in the hands of a department of the college of agriculture, the superintendent of which arranges the programmes and fixes all dates and places of meetings. While the Experiment Station furnished 16 lecturers last year, more than 1,000 local speakers were also used. There were 576 sessions of regular institutes held with an attendance of 37,191, besides 30 summer meetings and a wheat train which ran six days, making 72 stops, with an additional 6,768 in attendance. The total cost of the institutes was \$8,200, the State making a special appropriation of \$6,000.

County institute organizations are now found in 103 of the 105 counties in the State. In the eastern portion of the State the subject of roads was discussed at all meetings, and in the western portion of the State forestry and tree planting were substituted. The department now has charge also of the demonstration work on county and private farms, including road making, and of the demonstration classes in stock and corn judging, cooking, spraying, and dairying.

KENTUCKY.

Institute director.—M. C. Rankin, commissioner of agriculture, Frankfort.

Ten thousand six hundred and seven dollars and forty-four cents was expended on institute work last season. This made it possible to

hold 464 sessions at which 21,538 were in attendance. The college of agriculture and the experiment station furnished five lecturers, and subjects in veterinary science and in domestic science were introduced. State fairs and organization of farmers were discussed at all the meetings.

LOUISIANA.

Institute director.—Charles Schuler, commissioner of agriculture, Baton Rouge.

No farmers' institutes were held by the state department, but the college of agriculture conducted a number of farmers' conferences at which professors from the college and experiment station delivered addresses.

MAINE.

Institute director.—A. W. Gilman, commissioner of agriculture, Augusta.

During the year '79 sessions of regular institutes were held with an attendance of 8,267, while 5 independent institutes had 640 in attendance. The total cost was \$2,500, all paid for out of state funds. The college of agriculture furnished 2 speakers. The dates and the programmes are arranged by the commissioner, while the places of the meetings are selected by the county organizations.

MARYLAND.

Institute director.—Wm. L. Amoss, director of farmers' institutes, Benson.

Ninety-seven regular farmers' institutes were held during the year, at which 9,345 were in attendance. There were also institute schools with an attendance of 576 and a special corn train that attracted 1,085 people. The faculty of the college of agriculture and the experiment station staff lectured at as many institutes as their other duties would permit.

MASSACHUSETTS.

Institute director.—J. L. Ellsworth, secretary state board of agriculture, Boston.

Last year \$2,187.69 was used in institute work, 187 sessions being held with 20,756 in attendance, and two demonstration meetings which 400 attended. Twelve lecturers from the college of agriculture and the experiment station addressed meetings during the year.

MICHIGAN.

Institute director.—L. R. Taft, superintendent of farmers' institutes, East Lansing.

Institutes were held in the lower peninsula in all the counties except one. Altogether in both peninsulas there were 1,163 sessions of regular institutes with a total attendance of 147,438. Round-up

institutes were also held covering 12 sessions and with 10,125 as the attendance, and one normal institute lasting three days with 500 in attendance. One railroad special ran eleven days with 65 stops and had 7,485 visitors. Included in the regular institutes above given were 40 women's institutes which often showed a better interest and attendance than the general sessions. The superintendent consults with the officers of the local associations regarding the programmes, dates, and locations of the meetings. The State appropriated \$8,500 for this work, but the actual cost the past year was \$323.62 additional, which was provided for from a balance left over from the year previous. The above includes the salary and expenses of the state superintendent. The college of agriculture and the experiment station cooperated in the work by giving the services of 18 lecturers, and it is estimated that 1,200 local speakers addressed the meetings.

MINNESOTA.

Institute director.—A. D. Wilson, assistant in agriculture and director of farmers' institutes, college of agriculture, St. Paul.

The State appropriated \$18,000 for institute work during the past year which was all expended, and in addition about \$5,000 more was expended which was derived from advertisements in the annual and from a surplus left over from the year previous. This sum includes the salary and expenses of the state director. Twenty-seven state lecturers were employed and the college of agriculture contributed 9 lecturers.

There were held during the year 684 sessions of regular institutes with a total attendance of 109,625. A new feature was the holding of 81 one-session institutes in district schoolhouses which were very satisfactory and at which the attendance was 3,970. Women's institutes were held in five towns, one lady and part of the time two ladies holding one afternoon session each week for four weeks, with good appreciation and attendance. The attendance at a twelve weeks' course of agricultural lectures by members of the college of agriculture at a high school on Monday afternoons was 1,987, and at an eight weeks' course at another high school it was 1,525.

During the past year the institute management has assisted in the organization of 70 farmers' clubs, mostly representing school districts, but in some cases townships. They hold frequent meetings and study and discuss the various problems of importance in that region, such as seed and corn testing, selecting and breeding, co-operative buying and selling, good roads and the like, and they are proving to be of great value to the members. Twelve of the 16 clubs organized in one county a year ago held that year 94 meetings with a total attendance of 4,420, using home talent almost exclusively.

Industrial contests for boys and girls under 18 have been promoted and prizes awarded through the county superintendent of schools for production of corn, wheat, potatoes, vegetables, fruit, and in sewing and cooking. Those winning any of the first six prizes in any class in any county may compete at the state contest. The institute board employed a special man the past year to go from county to county and visit the schools in order to assist the school superintendent in starting this work. He spoke at the schools, and attended teachers' and school officers' meetings, and in ten weeks held 148 meetings with a total attendance of 12,393, mostly boys and girls.

MISSISSIPPI.

Institute director.—E. R. Lloyd, professor of agriculture, college of agriculture, Agricultural College.

The institutes which are under the charge of a department of the college of agriculture are cooperating with the county agricultural high schools as fast as they are established, and are developing short courses in agriculture and dairying.

One hundred and sixty-six sessions of regular institutes were held during the year with an attendance of 25,229, while 17 independent institutes with 5,580 in attendance, 8 sessions of round-up institutes with 1,000 in attendance, and 6 special trains with a total attendance of 12,846 were also held, making a grand total at all the special institutes of 19,426.

The total cost of the institutes was \$3,000, appropriated by the State, but not including the salary of the director.

MISSOURI.

Institute director.—G. B. Ellis, secretary state board of agriculture, Columbia.

During the year there were held 705 sessions of regular institutes with an attendance of 64,800, and 26 sessions of round-up institutes with 7,250 in attendance, besides a number of other special institutes of which no record was kept.

The expense of holding these meetings was \$5,000, all of which the State appropriated, but this does not include the salary of the director and his assistants. A new feature of the work was the conducting of extension short courses.

MONTANA.

Institute director.—F. S. Cooley, superintendent of farmers' institutes, College of Agriculture, Bozeman.

An annual report of the institutes is published and is a departure from the beaten track in that it treats of but one subject each year, thus giving an exhaustive supply of information regarding that particular phase of agriculture. As a different subject is dealt with

each year, in a few years there will be available a valuable and concise library of information on the agriculture of the State.

The state appropriation of \$7,500 was expended for institute work, including the salary and expenses of the director. There were held 126 sessions of regular institutes with an attendance of 10,831, and 52 lectures in high schools to 9,185 pupils and friends, besides a dairy train with 1,000 in attendance. The college of agriculture and the experiment station furnished 14 lecturers, while 8 state lecturers and 9 local speakers were used. Dry-land farming was discussed at nearly all meetings, and dry-farming demonstrations are being introduced, as well as movable schools of home making and high-school lecture courses.

NEBRASKA.

Institute director.—Val Keyser, superintendent of farmers' institutes, College of Agriculture, Lincoln.

A conference of local institute managers was held at one of the meetings of organized agriculture, at which questions pertaining to methods of conducting institutes were discussed. During the past year 500 sessions of regular institutes were held with a total attendance of 86,623, and two institute schools in agriculture and domestic science with 530, besides 6 special institutes, the attendance at which was not reported, and organized agriculture, which takes the place of a round-up institute, the attendance of which was also not reported. Five boys' and girls' sessions were held, and women's auxiliaries were held in connection with nearly all regular institutes. The institutes cost \$14,795.84, of which amount the State appropriated \$10,000, the university \$652.98, and counties and local institutes \$4,142.86.

NEVADA.

Institute director.—J. E. Stubbs, president of the university of Nevada, and director of the experiment station, Reno.

No farmers' institutes were held.

NEW HAMPSHIRE.

Institute director.—N. J. Bachelder, secretary state board of agriculture, Concord.

Twenty-four sessions of regular institutes with an attendance of 1,800 and 3 round-up sessions with 500 in attendance were held during the past year. There were also several field meetings with an attendance of 4,500. The college of agriculture provided 6 lecturers, while 6 state lecturers and 12 local speakers were employed. The State appropriated \$1,200 for institute work, but only half of this amount was expended.

NEW JERSEY.

Institute director.—Franklin Dye, secretary state board of agriculture, Trenton.

Approximately \$3,000 was expended for institute work last season. This enabled the holding of 128 sessions of regular institutes, at which 10,425 attended, and 7 sessions of round-up institutes, at which the attendance was 2,200. A railroad instruction train was run three days, stopping at 19 places, with 1,500 in attendance. Five members of the faculty of the college of agriculture and 2 of the staff of the experiment station lectured before some of the meetings.

NEW MEXICO.

Institute director.—J. D. Tinsley, professor of physics, college of agriculture, Agricultural College.

The Territory made no appropriation for farmers' institute work, but the college of agriculture, through its superintendent of institutes and with the help of two members of the experiment-station staff, held 50 sessions with an attendance of 1,696, at a cost of \$1,700, including salaries and expenses.

NEW YORK.

Institute director.—R. A. Pearson, commissioner of agriculture, Albany.

The institutes the past year covered all but 5 counties, which were either in the Adirondack Mountains or occupied by New York City and its environs. The college of agriculture and experiment station provided about 15 lecturers, one man being out all the time and giving two lectures each day. There were some 45 state lecturers in addition and about 150 local speakers were used. At most institutes the subject of rural schools was discussed.

The State appropriated \$25,000 for farmers' institute work during the year just closed, but the actual cost of the institutes was about \$28,000, not including the salary and expenses of the director. During the year 1,054 sessions of regular institutes were held, with an attendance of 155,602, besides 11 cooperative institutes which were held under the auspices of granges, poultry shows, agricultural schools, and the like, and at which the attendance was 16,517. One normal institute was held at which the lecturers were given the results of the latest information gathered by the college and experiment station.

NORTH CAROLINA.

Institute director.—T. B. Parker, director of farmers' institutes, department of agriculture, Raleigh.

During the year 514 sessions of regular institutes were held with 46,500 in attendance, and 18 sessions of round-up institutes with an

attendance of 1,000. The college of agriculture and the experiment station supplied 7 lecturers, and the total cost of the institutes was \$6,400, paid from the treasury of the state board of agriculture.

NORTH DAKOTA.

Institute director.—T. A. Hoverstad, superintendent of farmers' institutes, Fargo.

The institutes held during the year cost \$9,835.22, which represents the \$6,000 annually appropriated for this work and a surplus left over from the year previous. There were held 281 sessions of regular institutes with an attendance of 46,538, and a number of special institutes of which no record was kept. Leguminous crops were discussed at all the meetings. The college of agriculture and the experiment station each kept one speaker in the field all the time, and 3 state speakers were employed.

OHIO.

Institute director.—A. P. Sandles, secretary department of agriculture, Columbus.

No lecturers were used from the faculty of the college of agriculture nor from the staff of the experiment station, but the state lecturers numbered 52 and about 2,000 local speakers were used. During the year 4 regular institutes were held in every county in the State, making in all 1,760 sessions, and the interest was so intense that 400,000 people attended these meetings. There were also held 100 independent institutes with an attendance of 300,000, and 5 sessions of round-up institutes with 500 in attendance. No record was kept of the corn specials, fruit trains, corn schools, and orchard schools.

The State appropriated \$22,000 for the institute work, all of which was expended but did not include the salary and expenses of the director.

OKLAHOMA.

Institute director.—T. M. Jeffords, conductor of institutes, Elgin.

Corn growing was discussed at all the institutes. The college of agriculture furnished 8 lecturers; there were 10 on the state force and about 50 local speakers used. The total cost of the institutes for the year was \$4,500, which enabled the holding of 206 sessions of regular institutes with an attendance of 11,953, and 5 independent institutes with 672 in attendance.

OREGON.

Institute director.—James Withycombe, director of the experiment station, Corvallis.

The State appropriated \$2,500 for the institute work, and \$2,946.65 was expended, which included the salary and expenses of the director.

The experiment station supplied 4 lecturers and the State 2, while usually 2 local speakers were obtained at each meeting. There were in all 79 sessions of regular institutes with an attendance of 16,930, and 2 demonstration train institutes with a total of 40,730 people in attendance. The demonstration trains were reported to have been remarkably successful in point of interest and attendance. They were really traveling schools of agriculture, consisting of 4 coaches filled with demonstration material from the departments of agronomy, horticulture, animal husbandry, dairying, entomology, and poultry.

PENNSYLVANIA.

Institute director.—A. L. Martin, deputy secretary of agriculture, Harrisburg.

All the state institutes last year discussed horticulture, poultry, dairying, and the betterment of country home conditions. The movable institute school work was made more perfect. While no regular women's institutes were held, a session for women was held at each of the 172 two-day institutes which constituted the majority of the institutes, for only 24 one-day and 7 three-day institutes were held. In all there were 982 sessions of regular institutes, and the attendance was 156,652. There were also 10 independent institutes with 29,160 in attendance, and 9 sessions of round-up institutes with an attendance of 1,980. The college of agriculture and the experiment station helped in the work by sending in all 9 lecturers. The total cost of the institute work during the year was \$20,000, all appropriated by the State. The places at which institutes are to be held and the programmes are arranged by the local committee, while the state director arranges the dates.

PORTO RICO.

Institute director.—D. W. May, special agent in charge of Porto Rico Experiment Station, Mayaguez.

There is no special appropriation for institute work in Porto Rico, but the director of the agricultural experiment station and 6 members of his staff spent ten days in institute work the past year, holding 12 sessions with a total attendance of 700, and at an expense of \$400, which was divided equally between the experiment station and some planters. A planters' picnic was held, which 350 people attended, but it was largely social.

RHODE ISLAND.

Institute director.—J. J. Dunn, secretary state board of agriculture, Providence.

During the past year there were held 12 sessions of regular institutes with an attendance of 1,400, and also 6 lectures on horticulture in cooperation with the college of agriculture, at which there were 1,000 in attendance. The regular institutes cost \$187.29, and the horticultural lectures cost the college \$150 and the state board \$150.

SOUTH CAROLINA.

Institute director.—D. N. Barrow, professor of agriculture, Clemson College.

With an appropriation of \$755 from the State for institute work, but with an expenditure of only \$516.26, the director of the experiment station, with the assistance of 2 members of his staff and 2 lecturers from the college of agriculture, succeeded in holding 20 sessions of farmers' institutes during the year with a total attendance of 5,848.

SOUTH DAKOTA.

Institute director.—A. E. Chamberlain, superintendent of farmers' institutes, Brookings.

Seed grain, dairying, and beef production were subjects discussed at all the institutes the past year. The college of agriculture furnished 2 and the experiment station 10 lecturers, while 9 state lecturers were employed. The state appropriation of \$7,000 was all expended with the exception of \$5. There were held 325 sessions of regular institutes, which 44,357 people attended, besides 15 independent institutes with an attendance of 900, and seed trains running thirteen days and stopping at 92 towns which attracted 7,823 people.

TENNESSEE.

Institute director.—John Thompson, commissioner of agriculture, Nashville.

Growing live stock was a subject discussed at all regular farmers' institute meetings last year, of which there were 64 sessions with an attendance of 55,300. There were also 18 independent institutes, the attendance at which was not recorded, and 33 sessions of round-up institutes with 6,000 in attendance. A railroad special which ran 100 miles stopping at 13 towns was visited by 2,000 people. The total cost of the institutes was \$3,264, not including the salary and expenses of the director, which would add \$600 to the cost. The state appropriation for the work was \$5,000. Six members of the agricultural experiment station staff lectured, and 6 state lecturers were employed.

TEXAS.

Institute director.—E. R. Kone, commissioner of agriculture, Austin.

The law of 1907 creating the state department of agriculture made it the duty of the commissioner to organize farmers' institutes, but made no special appropriation for their maintenance. The legislature of 1909 appropriated \$5,000 annually for the fiscal years ending September 1, 1910 and 1911. This is the first appropriation for institute work in Texas, and a director of farmers' institutes will be appointed with headquarters at Austin, and precinct, county, and state organization will be undertaken.

The commissioner of agriculture has, however, done considerable farmers' institute work, using \$2,116 from some of the funds not

needed for other purposes, and as a result held 199 sessions of regular institutes last year with a total attendance of 11,049. Besides this, 6 institute picnics were held, attended by 10,000 people, some demonstration work was done, and exhibits made of farm products.

UTAH.

Institute director.—L. A. Merrill, superintendent of agricultural extension work of the college of agriculture and director of Utah state farmers' institutes, Salt Lake City.

Dairying and horticulture were discussed at all regular farmers' institute meetings held during the year, of which there were 217 sessions, with a total attendance of 18,089. Five local speakers addressed meetings, but, aside from this assistance, the work was all done by the director of institutes and the faculty of the college of agriculture and the members of the experiment station staff, at a cost of \$2,825.11, the state appropriation being \$1,500, the college supplying the deficiency.

VERMONT.

Institute director.—O. L. Martin, commissioner of agriculture, Plainfield.

With two state speakers and one lecturer from the experiment station for only one day the commissioner of agriculture held 12 sessions of regular institutes, with approximately 600 in attendance, and cooperated with the college of agriculture in conducting the farmers' week, at which 168 were registered, the total expenses being approximately \$350.

VIRGINIA.

Institute director.—G. W. Koiner, commissioner of agriculture, Richmond.

About \$2,000 was used in institute work during the year, enabling the holding of about one hundred and thirty days of institutes, with an attendance of 25,000. A steamboat was equipped, and with it a series of institutes were conducted along the Rappahannock River among the truck gardeners and other agricultural people in the vicinity.

The Virginia State Farmers' Institute is an organization established five years ago. It meets once each year for a three days' conference, with an elaborate programme, and has approximately 1,300 members. The proceedings of the fifth annual session, held at Richmond, August 4, 5, and 6, 1908, has been published and contains 282 pages. The organization is now to be incorporated.

WASHINGTON.

Institute director.—R. W. Thatcher, director agricultural experiment station, Pullman.

The farmers' institute work is in charge of the extension department of the college of agriculture, and practically all its appropria-

tion of \$5,000 was expended for institute work. There were 238 sessions of regular institutes held, with an attendance of 15,465. Three sessions of round-up institutes had an attendance of 116, and the 6 railroad specials made 103 stops, with a total of 28,990 in attendance. The grange is cooperated with and 4 sessions were addressed by the institute speakers, at which the attendance was 591. The college of agriculture and the experiment station contributed 11 lecturers, and there were 23 state lecturers and numerous local speakers to help in the work.

WEST VIRGINIA.

Institute director.—J. B. Garvin, secretary board of agriculture, Charleston.

With an expenditure of \$9,249.29 the board of agriculture held 356 sessions of regular institutes during the year, at which the attendance was 19,424, and 28 independent institutes, the attendance of which was not recorded. A special field man was employed by the year whose duty it was to go among the farmers and hold special meetings wherever and whenever he could get a few of them together. This must have resulted in a vast amount of good for the agricultural interests of the State, and it is along a line of work which has been in successful operation in many foreign countries for a number of years, and which can profitably be developed in this country.

WISCONSIN.

Institute director.—G. B. McKerrow, superintendent of farmers' institutes, Madison.

Bovine tuberculosis was discussed at all the general institutes during the year. About 50 state lecturers were in the employ of the institute besides some 20 local speakers and 7 or 8 lecturers from the college of agriculture and the experiment station at odd times. Seven hundred and five regular institute sessions were held and the total attendance was 93,090, and the cost nearly \$20,000, including the printing of bulletins.

WYOMING.

Institute director.—J. D. Towar, director of the experiment station, Laramie.

In spite of the fact that the grazing of cattle and sheep is still the predominant form of agriculture in Wyoming and small farms are relatively few, the institutes are doing good work and are developing from year to year. The local officers are always consulted regarding the arrangement of the meetings, and in some counties they pay the local expenses of holding the institutes. Seventy-one sessions of regular institutes were held, with 4,403 in attendance, and 5 women's institutes were also held. The expenditure from the state appropriation was \$933.18, and the college of agriculture and the experiment station furnished the director and 8 lecturers, while 12 were employed from the State at large.

STATISTICS OF FARMERS' INSTITUTES, 1909.

Number of institutes held and the approximate attendance during the year ended June 30, 1909.

State or Territory.	Number of one-day institutes.	Number of two-day institutes.	Number of three or more day institutes.	Total.	Total number of sessions.	Total attendance at sessions.	Average per session.
Alabama.....	22	2	.....	24	42	4,240	101
Alaska ^a.....	.....	.....	.....	.....	.....	.....	.....
Arizona.....	34	.....	.....	34	34	1,862	55
Arkansas.....	67	.....	3	70	150	44,161	294
California.....	60	26	7	93	250	28,294	113
Colorado.....	66	.....	4	70	130	22,560	173
Connecticut.....	24	1	.....	25	53	.....	.....
Delaware.....	18	5	.....	23	70	9,216	132
Florida.....	25	4	.....	29	56	5,576	100
Georgia.....	24	2	.....	26	56	4,480	80
Hawaii ^a.....	.....	.....	.....	.....	.....	.....	.....
Idaho.....	34	6	3	43	90	8,560	95
Illinois.....	.....	50	61	111	659	82,855	125
Indiana.....	184	164	3	351	1,162	215,211	185
Iowa.....	.....	69	14	83	415	103,750	250
Kansas.....	136	76	.....	212	576	37,191	64
Kentucky.....	.....	119	.....	119	464	21,538	46
Louisiana ^b.....	.....	.....	.....	.....	.....	.....	.....
Maine.....	37	1	.....	38	79	8,207	104
Maryland.....	46	10	.....	56	97	9,345	96
Massachusetts.....	136	.....	.....	136	187	20,756	111
Michigan.....	329	72	3	404	1,163	147,438	127
Minnesota.....	322	.....	2	332	684	109,625	160
Mississippi.....	114	2	2	118	166	25,229	152
Missouri.....	149	100	11	260	705	64,800	92
Montana.....	70	.....	2	72	178	20,016	112
Nebraska.....	35	109	.....	144	500	86,623	173
Nevada ^b.....	.....	.....	.....	.....	.....	.....	.....
New Hampshire.....	.....	.....	.....	12	24	1,800	75
New Jersey.....	33	5	.....	38	128	10,425	81
New Mexico.....	34	2	1	37	50	1,696	34
New York.....	162	110	4	276	1,054	172,119	164
North Carolina.....	233	.....	1	234	514	46,500	90
North Dakota.....	96	10	1	107	281	46,538	165
Ohio.....	.....	352	.....	352	1,760	400,000	227
Oklahoma.....	38	34	.....	72	206	11,953	58
Oregon.....	31	3	1	35	79	16,930	214
Pennsylvania.....	24	172	7	203	982	156,652	159
Porto Rico.....	10	.....	.....	10	12	700	58
Rhode Island.....	9	.....	.....	10	12	1,400	116
South Carolina.....	10	1	.....	10	20	5,848	292
South Dakota.....	24	62	2	88	325	44,357	103
Tennessee.....	31	.....	9	40	64	55,300	864
Texas.....	79	8	.....	87	199	11,049	55
Utah.....	41	11	1	53	217	18,089	83
Vermont.....	5	.....	.....	5	12	600	50
Virginia.....	130	.....	.....	130	260	25,000	96
Washington.....	67	17	.....	84	238	15,465	65
West Virginia.....	18	80	.....	98	356	19,424	54
Wisconsin.....	16	123	1	140	705	93,090	132
Wyoming.....	11	6	3	20	71	4,403	62
Total.....	3,046	1,822	146	5,014	15,535	2,240,925	144

^a No report.

^b No institutes held.

Financial statistics of the farmers' institutes for the year ended June 30, 1909.

State or Territory.	Funds appropriated.		Cost.		Appropriation for the season of 1909-10.
	State.	College and other funds.	Total cost.	Cost per session.	
Alabama.....	\$600.00	\$800.00	\$1,400.00	\$33.33	\$600.00
Alaska ^a					
Arizona.....	123.95		123.95	3.65	1,100.00
Arkansas.....	2,135.60	2,500.00	4,635.60	30.90	4,000.00
California.....	6,000.00	1,000.00	7,000.00	28.00	10,000.00
Colorado.....	5,000.00	4,242.42	9,242.42	71.10	5,000.00
Connecticut.....	257.67	374.30	^b 631.97	11.92	(^a)
Delaware.....	600.00	450.00	1,050.00	15.00	750.00
Florida.....	2,500.00		2,000.00	35.71	7,500.00
Georgia.....	2,500.00	4,500.00	7,000.00	125.00	2,500.00
Hawaii ^a					
Idaho.....	1,000.00		(^a)	(^a)	2,000.00
Illinois.....	15,000.00	4,043.75	19,043.75	28.90	20,000.00
Indiana.....	10,000.00	10,000.00	19,000.00	16.34	10,000.00
Iowa.....	6,030.51	4,020.07	10,050.58	24.21	(^a)
Kansas.....	6,000.00	2,200.00	8,200.00	14.24	25,000.00
Kentucky.....	10,607.44		10,607.44	22.86	(^a)
Louisiana ^c					
Maine.....	2,500.00	2,000.00	4,500.00	56.96	5,000.00
Maryland.....	6,000.00		6,000.00	61.85	6,000.00
Massachusetts.....	4,000.00		^b 2,187.69	11.70	4,000.00
Michigan.....	8,500.00	323.62	8,823.62	7.58	8,500.00
Minnesota.....	18,000.00	5,560.23	22,800.00	33.33	18,000.00
Mississippi.....	3,000.00	2,000.00	5,000.00	30.12	3,000.00
Missouri.....	5,000.00	3,500.00	(^a)	(^a)	5,000.00
Montana.....	7,500.00		7,500.00	42.13	8,000.00
Nebraska.....	10,000.00	4,795.84	14,795.84	29.59	10,000.00
Nevada ^c					
New Hampshire.....	1,200.00		^b 600.00	25.00	1,500.00
New Jersey.....	3,000.00		3,000.00	23.43	(^a)
New Mexico.....		1,800.00	1,700.00	34.00	(^a)
New York.....	25,000.00	3,000.00	^b 28,000.00	26.56	31,000.00
North Carolina.....	6,400.00		^b 6,400.00	12.45	(^a)
North Dakota.....	6,000.00	3,835.22	9,835.22	35.00	6,000.00
Ohio.....	22,000.00		^b 23,000.00	13.07	23,000.00
Oklahoma.....	3,000.00	1,800.00	4,500.00	21.84	6,000.00
Oregon.....	2,500.00	500.00	2,946.65	37.30	2,500.00
Pennsylvania.....	20,000.00	3,000.00	23,000.00	23.42	25,500.00
Porto Rico.....		400.00	^b 400.00	33.33	(^a)
Rhode Island.....	243.64	243.65	487.29	40.61	(^a)
South Carolina.....	755.00		516.26	25.81	1,000.00
South Dakota.....	7,000.00		6,995.00	21.52	10,000.00
Tennessee.....	5,000.00		3,864.00	60.37	5,000.00
Texas.....	2,116.00		2,116.00	10.63	5,000.00
Utah.....	1,500.00	1,325.11	2,825.11	13.01	5,000.00
Vermont.....	1,000.00		1,000.00	83.33	1,000.00
Virginia.....	2,000.00		(^a)	(^a)	(^a)
Washington.....	5,000.00		^b 5,000.00	21.00	5,000.00
West Virginia.....	9,249.29		9,249.29	25.98	(^a)
Wisconsin.....	20,000.00		20,000.00	28.36	20,000.00
Wyoming.....	1,000.00	633.18	1,633.18	23.00	1,000.00
Total.....	276,819.10	68,847.39	328,660.86	21.15	304,450.00

^a No report.

^b Not including the salary of the director.

^c No institutes held.

Comparative statement of farmers' institutes.

State or Territory.	Appropriations.			Number of sessions.		Number of institutes.			Attendance.		
	1906-7	1907-8	1908-9	1907-8	1908-9	1906-7	1907-8	1908-9	1906-7	1907-8	1908-9
Alabama.....	\$600.00	\$1,000.00	\$1,400.00	73	42	24	40	24	2,857	8,844	4,240
Alaska ^a											
Arizona.....	300.00	1,745.00	123.95	56	34	20	56	34	1,000	2,673	1,862
Arkansas.....		1,500.00	4,635.60	64	150	40	56	70	3,000	5,596	44,161
California.....	6,000.00	8,000.00	7,000.00	294	250	84	88	93	20,470	27,912	28,294
Colorado.....	5,003.19	7,724.46	9,242.42	240	130	62	126	70	16,960	38,930	22,560
Connecticut.....	2,435.57	1,700.00	631.97	53	53	38	25	25	9,522	3,700	(^a)
Delaware.....	700.00	725.00	1,050.00	52	70	12	19	23	9,210	4,905	9,210
Florida.....	7.00	2,500.00	2,500.00	29	56	1	26	29	3,316	5,576	
Georgia.....	2,500.00	4,000.00	7,000.00	84	56	(^a)	40	26	(^b)	12,000	4,480
Hawaii.....	62.05	74.49		4	(^a)	3	4	(^a)	500	150	(^a)
Idaho.....	142.08	1,000.00	1,000.00	66	90	1	12	43	550	5,650	8,560
Illinois.....	28,978.96	29,540.00	19,043.75	627	659	111	108	111	333,350	122,523	82,855
Indiana.....	12,700.00	18,000.00	20,000.00	1,112	1,162	281	321	351	177,441	195,912	215,211
Iowa.....	7,425.00	7,954.98	10,050.58	400	415	85	75	83	51,000	75,000	103,750
Kansas.....	4,064.00	6,495.51	8,200.00	473	576	135	176	212	20,200	33,684	37,191
Kentucky.....	13,000.00	8,982.85	10,607.44	514	464	123	132	119	26,836	21,690	21,538
Louisiana.....	2,000.00	2,000.00	(^b)	(^b)	(^b)	10	(^b)	(^b)	(^a)	(^b)	(^b)
Maine.....	5,000.00	3,000.00	4,500.00	97	79	33	50	38	4,771	14,143	8,267
Maryland.....	6,000.00	6,000.00	6,000.00	117	97	23	41	56	9,833	8,903	9,345
Massach'tts.....	2,750.00	4,000.00	4,000.00	156	187	126	127	136	19,692	18,412	20,756
Michigan.....	15,500.00	8,500.00	8,823.62	969	1,163	329	326	404	115,136	121,654	147,438
Minnesota.....	20,665.00	20,454.50	23,560.23	547	684	139	272	332	67,063	92,091	109,625
Mississippi.....	3,000.00	5,000.00	5,000.00	274	166	148	129	118	17,945	28,910	25,229
Missouri.....	5,000.00	5,000.00	8,500.00	875	705	212	250	260	46,511	40,000	64,800
Montana.....	5,000.00	7,500.00	7,500.00	156	178	70	72	72	7,541	12,293	20,016
Nebraska.....	8,684.04	13,617.68	14,795.84	602	500	136	175	144	65,419	93,824	86,623
Nevada ^b											
N. Hampsh'he.....	1,600.00	1,000.00	1,200.00	32	24	15	16	12	3,500	2,500	1,800
New Jersey.....	3,060.98	2,500.00	3,000.00	120	128	44	37	38	10,399	10,154	10,425
New Mexico.....	1,900.00	1,425.00	1,800.00	68	50	24	50	37	970	3,685	1,696
New York.....	20,000.00	25,000.00	28,000.00	1,471	1,054	211	307	276	105,196	149,418	172,119
N. Carolina.....	6,500.00	7,500.00	6,400.00	423	514	124	194	234	31,980	52,978	46,500
N. Dakota.....	6,000.00	6,721.65	9,835.22	233	281	25	90	107	9,709	38,000	46,538
Ohio.....	22,000.00	23,986.15	22,000.00	1,490	1,760	299	298	352	92,303	461,515	400,000
Oklahoma.....	550.00	1,285.29	4,800.00	.....	206	40	(^b)	72	6,715	(^b)	11,953
Oregon.....	3,000.00	2,500.00	3,000.00	79	79	58	32	35	22,200	7,500	16,930
Pennsylv'a.....	20,500.00	23,000.00	23,000.00	989	982	394	217	203	147,895	145,353	156,652
Porto Rico.....	(^b)	(^b)	400.00	(^b)	12	(^b)	(^b)	10	(^b)	(^b)	700
Rhode Isl'd.....	75.00	125.00	487.29	16	12	7	15	10	600	1,800	1,400
S. Carolina.....	3,000.00	2,000.00	755.00	41	20	73	40	10	13,219	13,392	5,848
S. Dakota.....	5,000.00	7,000.00	7,000.00	290	325	71	86	88	26,000	43,560	44,357
Tennessee.....	5,000.00	5,000.00	5,000.00	186	64	48	84	40	10,400	18,915	55,300
Texas.....	(^b)	382.25	2,116.00	.....	199	(^b)	36	87	(^b)	(^b)	11,049
Utah.....	(^a)	3,485.32	2,825.11	288	217	(^a)	25	53	(^a)	26,926	18,089
Vermont.....	5,000.00	5,000.00	1,000.00	56	12	34	28	5	7,288	5,160	600
Virginia.....	c2,500.00	(^a)	2,000.00	(^a)	260	c7	(^a)	130	c310	(^a)	25,000
Washington.....	(^a)	5,000.00	5,000.00	240	238	24	78	84	5,250	15,346	15,465
W. Virginia.....	7,476.71	5,644.41	9,249.29	365	356	110	112	98	24,825	16,748	19,424
Wisconsin.....	12,771.09	20,000.00	20,000.00	567	705	61	141	140	49,989	89,244	93,090
Wyoming.....	1,000.00	1,000.00	1,633.18	46	71	12	11	20	1,292	3,359	4,403
Total.....	284,450.67	325,569.54	345,666.49	14,934	15,535	3,927	4,643	5,014	1,596,877	2,098,268	2,240,925

^a No report.^b No institutes.^c Report for two districts only.

Number of lecturers employed by the state directors of farmers' institutes during the year ended June 30, 1909.

State or Territory.	Total number of lecturers on the state force.	Number of members of agricultural college and experiment station staffs engaged in institute work.	Number of days contributed to institute work by the agricultural college and experiment station staff.	Total number of days of institutes held during the year.	Reports of proceedings	
					Published.	Number of copies.
Alabama.....	15	12	.....	26	No.....	.....
Alaska ^a.....	.....	.....	.....	.....	No.....	.....
Arizona.....	.....	4	34	34	No.....	.....
Arkansas.....	18	23	250	76	No.....	.....
California.....	30	10	108	133	Yes.....	12,500
Colorado.....	21	37	.....	78	No.....	.....
Connecticut.....	35	8	20	26	Yes.....	600
Delaware.....	15	4	23	28	No.....	.....
Florida.....	15	7	.....	33	No.....	.....
Georgia.....	19	12	58	28	Yes.....	2,000
Hawaii ^a.....	.....	.....	.....	.....	.....	.....
Idaho.....	13	7	45	55	No.....	.....
Illinois.....	77	29	160	283	Yes.....	50,000
Indiana.....	55	11	59	521	No.....	.....
Iowa.....	14	11	.....	180	.....	.....
Kansas.....	36	20	276	288	No.....	.....
Kentucky.....	32	5	.....	238	Yes.....	25,000
Louisiana ^b	10	.....	.....	.....	.....	.....
Maine.....	18	2	.....	39	Yes.....	6,000
Maryland.....	19	.....	.....	66	.....	.....
Massachusetts.....	63	12	20	136	No.....	.....
Michigan.....	51	18	115	482	Yes.....	12,000
Minnesota.....	26	9	15	344	Yes.....	45,000
Mississippi.....	22	14	294	124	Yes.....	10,000
Missouri.....	29	13	.....	382	Yes.....	10,000
Montana.....	19	14	134	76	Yes.....	7,000
Nebraska.....	26	32	142	253	Yes.....	3,000
Nevada ^b	11	.....	.....	.....	.....	.....
New Hampshire.....	17	6	12	12	Yes.....	1,500
New Jersey.....	10	6	77	43	Yes.....	6,000
New Mexico.....	8	2	15	41	No.....	.....
New York.....	68	16	128	394	Yes.....	.....
North Carolina.....	30	7	59	236	Yes.....	35,000
North Dakota.....	9	1	185	119	Yes.....	15,000
Ohio.....	51	.....	.....	704	Yes.....	25,000
Oklahoma.....	22	8	120	106	No.....	.....
Oregon.....	11	4	150	40	No.....	.....
Pennsylvania.....	68	9	115	389	Yes.....	8,000
Porto Rico.....	.....	6	60	10	No.....	.....
Rhode Island.....	15	9	.....	11	Yes.....	2,000
South Carolina.....	5	4	14	10	.....	.....
South Dakota.....	.....	12	60	160	No.....	.....
Tennessee.....	10	6	40	58	No.....	.....
Texas.....	.....	5	65	95	No.....	.....
Utah.....	15	21	385	66	Yes.....	10,000
Vermont.....	.....	1	1	5	Yes.....	.....
Virginia.....	9	.....	.....	130	.....	.....
Washington.....	30	11	181	101	No.....	.....
West Virginia.....	19	3	21	178	Yes.....	300
Wisconsin.....	26	.....	.....	265	Yes.....	60,000
Wyoming.....	14	8	.....	32	No.....	.....
Total.....	1,130	459	3,381	7,134	.....	345,900

^a No report.

^b No institutes held.

PROGRESS REPORT OF INVESTIGATIONS IN HUMAN NUTRITION IN THE UNITED STATES, 1905-1909.

By C. F. LANGWORTHY, *In Charge of Nutrition Investigations.*

INTRODUCTION.

For many years progress in the study of various phases of nutrition has been continuous in the United States. The articles which are included in this summary of work reported during the years 1905-1909, inclusive, have appeared in the reports and bulletins of the United States Government and of the agricultural experiment stations, scientific journals, reports of institutions, and similar publications.

It is recognized that the list of investigations cited is by no means complete, but it is believed that enough has been brought together to show that the work has grown and that important contributions have been made, not only to the fund of available data of interest to students of nutrition and to practical workers, but also to the subject or methods of investigation and to the more important question of the fundamental theories of nutrition. A similar summary has appeared in an earlier publication^a of this Office, and it is believed that such surveys are timely and useful as a means of showing the progress which is being made in America in the study of food and nutrition.

It is characteristic of the situation that as heretofore a large number of the investigations which have been reported were carried out under governmental or institutional auspices, and it may make the summary of the investigations themselves simpler if a brief statement concerning the relation of the more important of these agencies to nutrition work is given.

CONTRIBUTORS TO THE SUBJECT OF NUTRITION.

The War and the Navy departments, the Department of Commerce and Labor, and the Department of Agriculture are the branches of the Federal Government in which naturally most attention is directed to topics which are related to the problems of nutrition. In the offices of the Commissary-General of the War Department, the

^a U. S. Dept. Agr., Office Expt. Stas. Rpt. 1905, p. 225.

question of the food supply of troops and of camp cookery has always been one calling for careful study, and the results of such investigations are frequently of value to the students of general nutrition, as are similar ones conducted by the Navy Department.

The more strictly economic phases of the question, such as the relation of the cost of food to the other items of expenditure, and the statistics of the production and consumption of food products, fall within the province of the Department of Commerce and Labor, which now includes the Bureau of the Census. The Bureau of Fisheries of the same department also furnishes valuable data regarding American food fishes.

In the Department of Agriculture various features of the subject are naturally investigated, as the utilization of agricultural products as food for man is a very important part of the general subject of agriculture. The Bureau of Chemistry is charged with the chemical examination not only of agricultural products, but under the Food and Drugs Act, with the inspection of all materials coming within the scope of that law.

Similarly, the Bureau of Plant Industry, though it works primarily to improve crop production, nevertheless, by its studies of new varieties of food plants and of old varieties grown under special conditions, contributes to the knowledge of the nutritive values of these products. In like manner, the Bureau of Animal Industry, in conducting studies of meat, poultry, and dairy products, and also in investigating the problems of animal metabolism, has added much of value to the science of human nutrition. Such features of the work of these bureaus bring out the fact that very many food questions are in the last analysis agricultural questions.

During the last fifteen or twenty years special nutrition investigations have been carried on by congressional appropriations, placed under the direction of the Office of Experiment Stations of the Department of Agriculture, which serves as a sort of national clearing-house for the agricultural experiment stations now existing in all the States and Territories of the Union, and which, therefore, is in an unusually good position not only to coordinate and assist the work being done by individual investigators at the stations and elsewhere, but also to disseminate the results of such work. In the past little actual research was done in the central office in Washington, the work of which consisted rather in planning and publishing the results of research carried out by the cooperating investigators or institutions elsewhere; but since the completion of the new laboratories of the Department of Agriculture, the work formerly carried on in Middletown, Conn., with the Atwater-Rosa respiration calorimeter and other lines of investigations, has been moved to Washington. Among the

problems which are being studied or which it is proposed to take up shortly are the relative value as sources of nutrients and energy of the various fats of animal and vegetable origin, the digestibility of various kinds of cheese and other dairy products, and the measurement of the muscular work involved in performing various household tasks and common body activities with a view to determining the energy requirements of persons in various situations in life. Much attention is also being given to problems concerned with the economical use of foods in the home.

Among the most important features of these nutrition investigations of the Office of Experiment Stations is the opportunity afforded for publishing the results of such work. Besides the technical bulletins reporting new investigations, which are sold at low prices (usually from 5 to 50 cents a bulletin), there is a series of popular articles known as Farmers' Bulletins and intended for free distribution in the United States. These are popular but accurate summaries of the results of technical inquiries along various lines. The series also contains occasional numbers known as Experiment Station Work and giving brief accounts of recent special investigations at the various agricultural experiment stations, and thus keeping readers in touch with the work actually in progress. The Experiment Station Record, a monthly review of American and foreign publications of interest to students of agriculture and other sciences, contains a section devoted to human food and nutrition, in which the more important current contributions to the subject are abstracted.

Aside from the work which the agricultural experiment stations of various States have done in cooperation with the nutrition investigations of the Office of Experiment Stations, a considerable number of them have made independent and extensive contributions to the subject. Frequently a station works on problems of especial interest in its locality; for example, the California Station has investigated the food value of fruit and nuts, and the Minnesota Station the baking qualities and digestibility of wheat products. Others, however, conduct experiments of general character, such as the studies of dietaries and digestion experiments of the Connecticut Storrs Station, and the studies of the structure of proteids of the Connecticut State Station, and many cooperate with the States in the analysis of food materials on sale in local markets and other work pertaining to state pure food laws and their enforcement.

The state boards of health and similar offices occasionally investigate questions bearing upon nutrition. The work of these state institutions is usually published in special reports and is often rather difficult of access, though more important features generally find their way into the scientific journals.

Many hospitals, both public and private, maintain well equipped laboratories in which excellent work is done, much of which is of interest to students of nutrition.

A few privately endowed institutions also do research work along medical and physiological lines. Of unusual importance in this connection is the nutrition laboratory of the Carnegie Institution of Washington which has been erected near the new buildings of the Harvard Medical School in Boston, Mass. This laboratory, which is under the direction of Dr. F. G. Benedict, formerly associated with Professor Atwater at Wesleyan University, is one of the most completely equipped of its kind in the world, and elaborate investigations with respiration calorimeters and other special apparatus are being carried on in which studies of nutrition under pathological conditions will be an important feature.

Besides the various classes of institutions already enumerated, there is a constantly increasing number of individuals, especially in university and medical school laboratories, who are doing work of high grade along the lines of nutrition and whose reports appear in university publications and in scientific journals, both American and foreign.

The practical application of the results of scientific nutrition investigation to the improvement of living conditions which is being made by leading students, by individuals, by institutions and organizations is a very gratifying feature of the work in the United States. The home economics movement, which is making rapid headway in the United States, is doing much to spread accurate knowledge of food and nutrition. Such subjects are being introduced into many schools and into an increasing number of agricultural and other colleges. They are also becoming prominent in the programmes of women's clubs and in the courses in correspondence schools. The Federal Department of Agriculture and the Bureau of Education cooperate in such movements, by their literature and their aid in formulating general plans.

A school of household science has been held in connection with the last two sessions of the Graduate Summer School of Agricultural Science organized by the Office of Experiment Stations, and it is expected will be continued in coming years. At the previous meetings courses have been presented on nutrition and allied topics, which have proved of great benefit and a stimulus to the many teachers in attendance.

In this connection mention should also be made of the newly formed American Home Economics Association, which aims to encourage and coordinate efforts for "the improvement of living conditions in the home, the institutional household, and the community."

Finally, mention should be made of the increasing attention paid to the task of bringing institution dietaries into accord with the suggestions of the best authorities on nutrition; this may be seen both in the emphasis laid on such questions in institutional reports and in the demand for thoroughly trained dietitians.

Such are, in general terms, the agencies by which work in problems of nutrition is being carried on in the United States. In the second and more specific part of this résumé it is proposed to enumerate the more important of the many investigations made during the last four or five years. Not a few embrace more than one phase of the subject, and thus put a strict classification out of the question. As far as possible, however, they will be grouped according to their subject-matter.

STUDIES OF FOODS AND FOOD PRODUCTS.

No new food products of special importance have appeared during the period under consideration in this summary, though some of minor importance have been studied. Nutrition studies of the nutritive value of well-known food materials have appeared, including dairy products, fruits, meats, and other materials.

Methods of analysis have, as usual, received a great deal of attention. The bulk of the work has to do with the inspection of foods under pure-food laws. No attempt can be made to summarize this work here, as taken in connection with other pure-food work it constitutes a subject in itself.

For its general interest mention should be made of the work of Howard^a of the Bureau of Chemistry of this Department on the use of the microscope for the detection of food adulteration.

Briggs,^b of the Bureau of Plant Industry of this Department, has reported a method for determining the moisture content of grain, which depends upon variations in electrical resistance. It was found that this factor was fifty times greater in wheat containing 13 per cent of moisture than in wheat containing 15 per cent. An advantage claimed for this method is its rapidity, the individual determinations requiring only two or three minutes.

From numerous experiments Fries^c reaches the conclusion that carbon dioxid may be determined with great accuracy in connection with determinations of heat of combustion by a modification of the Atwater-Berthelot bomb. He also reports data which indicate that the bomb may be equally well used for the determination of hydrogen.

For some time confusion has existed as to the terminology of nitrogenous constituents of foodstuffs, so particular interest attaches to the

^a U. S. Dept. Agr., Yearbook 1907, p. 379.

^b U. S. Dept. Agr., Bur. Plant Indus. Circ. 20.

^c Jour. Amer. Chem. Soc., 31 (1909), No. 2, p. 272.

report^a on this matter of the joint committee of American physiologists and biochemists. Their principal recommendation is that the word "proteid" be abandoned and that the word "protein" be used to designate substances which essentially consist, in so far as known at present, of combinations of α -amino acids and their derivatives.

Many analyses of food materials have accumulated in connection with studies of various nutrition problems, but no attempt is made here to summarize such incidental analytical work.

The subject of milk, butter, cream, and dairy products in general is so large that it deserves an independent summary. Much of the work has to do with the factors which affect purity, keeping quality, and similar questions.

Students of nutrition will perhaps be particularly interested in tests of milking machines, as it is believed that the use of such devices may result in a cleaner milk supply. The problem has been studied by Hæcker and Little of the Nebraska Experiment Station, and Woll and Humphrey of the Wisconsin Experiment Station.^b

Doane and Lawson^c have made a useful summary of the character, methods of manufacture, and composition of the various kinds of cheese commonly found in American markets.

The factors which influence the whipping of cream have been studied by Melick^d of the Maryland Experiment Station, and Michels^e of the North Carolina Experiment Station summarizes a large amount of data regarding the manufacture of cottage cheese and skim-milk buttermilk, a product sold in large quantities at the present time under the title of "buttermilk," but which it is said is made by churning sour skim milk so that the curd is finely broken and evenly distributed throughout the whey. The butter-fat content may be readily made to correspond to that of natural buttermilk by using a mixture of skim milk and whole milk.

In a farmers' bulletin entitled "The Use of Milk as Food," R. D. Milner^f summarizes and discusses data on the composition, digestibility, and food value of milk and milk products, the use of these materials in the home, and other related topics.

Various investigations have been made in sugar-growing States regarding the value of molasses prepared in different ways. Considerable quantities of sulphured molasses were included in the diet of healthy Louisiana negroes^g in studies by Blouin, Archinard, and

^a Science, n. ser., 27 (1908), p. 554.

^b Nebraska Sta. Bul. 108, Wisconsin Sta. Bul. 173, and Research Bul. 3.

^c U. S. Dept. Agr., Bur. Anim. Indus. Bul. 105.

^d Maryland Sta. Bul. 136.

^e North Carolina Sta. Bul. 202.

^f U. S. Dept. Agr., Farmers' Bul. 363.

^g Louisiana Sta. Bul. 94.

Hall of the dietetic use of such material. Extended studies^a of commercial table sirups made by the Bureau of Chemistry, while they belong primarily to the section on pure foods, should at least be mentioned here.

Sy^b has summarized a large amount of historical, botanical, and chemical data regarding the history, manufacture, and analyses of maple products, and reports experimental studies carried on with a view to isolating the flavoring substances present in maple sap.

C. A. Brown^c has reported results of extensive study of American honeys with a view to their classification and the identification of different sorts. His bulletin contains also results of microscopic studies of pollen and other substances which are found in honey. This work is designed to facilitate the judging of honey in pure-food work.

Van Dine and Miss Alice R. Thompson^d have reported studies of Hawaiian honeys, a number of which consist chiefly or entirely of honeydew which the bees collect after it has been exuded by certain insects instead of plant nectar.

The Bureau of Plant Industry has cooperated with the New Mexico Experiment Station in a study of the use of tuna and other sorts of cactus fruit as food. A report by Griffiths and Hare^e describes the manufacture of cactus jam, cactus cheese (a thick paste like old-fashioned apple marmalade), and other products, reports analytical data and discusses other questions of interest in connection with the use of this fruit, which is of much importance in the southwestern United States and other warm regions and is not infrequently found under the name of Indian fig or prickly pear in fruit shops at least in large cities.

Gore^f of the Bureau of Chemistry has studied the composition of different sorts of grape juice and reports interesting and valuable results.

L. H. Merrill^g has recently published a summary of miscellaneous work on nutrition carried on at the Maine Experiment Station, which includes studies of the composition of tropical fruits and vegetables and a variety of other foods, studies of the chemical changes brought about by popping corn, determination of the digestibility of hulled corn, and a study of the quality and character of so-called Graham flour.

^a U. S. Dept. Agr., Yearbook 1905, p. 241.

^b Jour. Franklin Inst., 166 (1908), p. 249; Chem. Abs., 2 (1908), No 24, p. 3376.

^c U. S. Dept. Agr., Bur. Chem. Bul. 110.

^d Hawaii Sta. Bul. 17.

^e U. S. Dept. Agr., Bur. Plant Indus. Bul. 116, p. 73; see also New Mexico Sta. Bul. 64.

^f Jour. Indus. and Engin. Chem., 1 (1909), No. 7, p. 436.

^g Maine Sta. Bul. 158.

At the Arizona Experiment Station, Vinson ^a has continued his important studies of the ripening of fruits, particularly dates, and finds that ripening may be stimulated in this fruit by a large number of substances, particularly those which are readily volatile; among the more important was acetic acid. He concludes that dates may be shipped green and then ripened where sold, by exposure to acetic acid fumes, a matter of much importance commercially, since the ripe date is so soft that it will not bear shipment. An extended study of date constituents and the chemistry of the date fruit is involved in his work.

As part of the pure-food work of the Connecticut State Experiment Station, A. L. Winton ^b reports an interesting study of nut butters, gluten goods, and other diabetic foods, and discusses their nutritive value and use in invalid dietetics.

Fetterolf ^c analyzed a number of sorts of gluten flour manufactured in the United States and also diabetic products of foreign origin. In both classes of food the amount of carbohydrates varied within rather wide limits, being sometimes notably high. An analysis of peanuts was also reported; also of so-called raspberry jelly, marketed for diabetics, which proved to be a wholly artificial product made of apple juice, glycerol, anilin coloring, and artificial raspberry flavoring.

As part of a study of breakfast foods, Frear ^d examined, with negative results, a number of samples of these goods with respect to the alleged occasional presence of material such as morphin and strychnin. This is a matter of interest in view of the persistence of popular statements to the effect that cereal breakfast foods sometimes contain such materials, a statement which is apparently without any foundation of fact.

The marine algæ most used for food by the natives of Hawaii have been classified and analyzed by Minnie Reed, ^e who has also made interesting notes regarding the food habits of the islanders.

For some time past efforts have been made to utilize cotton-seed meal, a cheap product rich in protein, but sometimes at least poisonous to certain animals, notably pigs, when eaten continuously, though harmless to others, and so a material demanding careful study. Wait ^f has recently proposed a new method of preparing it by which it is claimed that the toxic quality is removed and by which it can be satisfactorily mixed with corn meal (maize meal) or wheat for

^a Science, n. ser., 30 (1909), No. 774, p. 604.

^b Connecticut State Sta. Rpt. 1906, pt. 2, p. 153.

^c University of Pennsylvania Medical Bul. 22 (1909), No. 7, p. 217.

^d Penn. Dept. Agr. Bul. 162.

^e Hawaii Agr. Expt. Sta. Rpt. 1906, p. 61.

^f Oper. Miller, 13 (1908), No. 6, p. 280.

making bread or tea biscuit, but as yet the matter is hardly beyond the experimental stage.

Cooking oils, which are usually highly refined cotton-seed oil and olive oils, are discussed by Allen and Hill ^a of the North Carolina department of agriculture. Apparently, they conclude, olive oil is not adulterated at the present time. They conclude further "that some of the cooking oils are very desirable for culinary purposes and that cotton-seed oils used for cookery are seldom adulterated."

In a paper on the detection of sulphites in food, J. T. Willard ^b gives data on the liberation of sulphur in the cooking of green vegetables, a fact which earlier observers have shown to be due to protein cleavage.

Several American investigators have given attention to composition of eggs and related subjects. For instance, the infection and preservation of eggs was studied by Lamson ^c at the Connecticut Storrs Experiment Station.

J. T. Willard and R. H. Shaw ^d report analyses of a large number of eggs, with special reference to the proximate composition, thickness of the shell, and the percentage of phosphoric acid in the ash of the yolk. According to their results the ash consists quite largely of phosphoric acid, derived almost wholly from the egg yolk lecithin.

In "The Egg Trade of the United States" Hastings ^e discusses eggs from the standpoint of the dealer as well as the consumer, and such questions as quality, grade, and detrimental changes in eggs, and methods of marketing, storing, and preserving eggs.

The collection, use, and characteristics of penguin eggs, which are used to a considerable extent in South Africa, have been described in a popular article.^f

The studies of meat products which have been reported are fairly extensive as well as important. At the University of Missouri, Trowbridge and his associates have studied the determination of phosphorus in flesh,^g changes in the composition of the skeleton of beef animals,^h and the composition of the fat of beef animals on different planes of nutrition.ⁱ

Grindley and his associates^j at the University of Illinois have carried on a long series of studies on the chemistry of raw and cooked

^a Bul. N. C. Dept. Agr., 29 (1908), No. 12, p. 26.

^b Bul. Kansas State Bd. Health, 4 (1908), No. 9, p. 216.

^c Connecticut Storrs Sta. Bul. 55.

^d Kansas Sta. Bul. 159.

^e U. S. Dept. Agr., Bur. Anim. Indus. Circ. 140.

^f Sci. Amer. Sup., 66 (1908), No. 1716, p. 330.

^g Jour. Indus. and Engin. Chem., 1 (1909), No. 9, p. 675.

^h Ibid. No. 10, p. 725.

ⁱ Ibid. No. 11, p. 761.

^j Jour. Indus. and Engin. Chem., 1 (1909), No. 7, p. 413.

flesh, with reference to the effects of cold storage, both beef and poultry being used. The results are reported in detail and it is difficult to summarize them briefly. However, it may be noted that during storage an increase was observed in the soluble dry matter, nitrogenous, nonnitrogenous, and total organic extractives, and in the total soluble nitrogen and the soluble inorganic phosphorus, the differences being greater with long than with short periods of storage. (See also p. 375.)

The problem of the effects of storage on the character and quality of beef was also studied by Richardson.

W. Koch^a has studied the composition of normal and diseased brains and discusses his work with reference to the value of phosphorus compounds as brain foods. His conclusion is that sufficient phosphorus for the growth of the brain is supplied by the ordinary daily foods. If larger amounts are desired they may readily be secured by the use of such materials as eggs, sweetbread, liver and some meats. He does not recommend the use of commercial phosphorus preparations.

Considerable work has also been carried on with meat extracts. Bigelow and Cook^b report the result of analyses of a large number of samples of commercial goods of this character, discusses the composition, food value, and uses of such materials, methods of manufacture, and other related questions. In addition to the experimental work reported, their bulletin is a digest of useful data regarding this class of food products.

At the Connecticut State Station, Street and his associates^c carried on an exhaustive study of meat extracts and similar goods, which is of the same general character as the work of the Bureau of Chemistry, and like it constitutes an important and useful summary of data in addition to the results of a large amount of analytical work. Yeast extracts, a class of goods sometimes referred to as "vegetable" meat extracts, were also included in the investigation, as well as meat extracts.

E. T. Williams^d has investigated the value of animal spleens as food for man, and concludes that while, owing to their soft texture, they will not keep for any length of time, these usually discarded organs furnish in their fresh state a nutritious and digestible food.

Dogfish and other hitherto unutilized fishes have also been tested and found suitable for human consumption. I. A. Field^e reports data on the utilization of such fishes—fresh, canned, and dried.

^a Jour. Amer. Med. Assoc., 52 (1909), No. 18, p. 1381.

^b U. S. Dept. Agr., Bur. Chem., Bul. 114.

^c Connecticut State Sta. Bien. Rpt. 1907-8, pt. 9, p. 606.

^d Amer. Med., 11 (1906), No. 6, p. 215, n. ser., 2 (1907), No. 9, p. 522.

^e U. S. Dept. Com. and Labor, Bur. Fisheries Doc. 622.

Of special studies of food composition with reference to nutritive value may be mentioned the following, which are also noteworthy for the contribution they make to the subject of experimental methods.

Grindley and Woods^a have developed methods for determining creatin and creatinin in meats and their products. They used the colorimetric method described by Folin and found it applicable to cooked and uncooked meats as well as such products as meat extract.

Osborne and Heyl^b studied the hydrolysis of fish muscle and determined the amounts of nitrogen present in different forms. The nitrogen contained in the histidin, arginin, and lysin was 4.16 per cent, 0.79 per cent less than the basic nitrogen precipitated by phosphotungstic acid, a difference believed to be due to the presence in the muscle of basic substances of nonprotein origin.

During the last few years numerous papers by T. B. Osborne have appeared in various scientific journals regarding proteids of maize, of wheat, and of other seeds and grains. The report of his investigation on the proteids of the wheat kernel, recently published by the Carnegie Institution of Washington,^c is one of the most exhaustive and valuable discussions of the nitrogenous constituents of wheat which has appeared and summarizes a large amount of the author's experimental work.

Other contributions by Osborne and his associates to this important series of investigations carried on at the Connecticut State Experiment Station are studies of the hydrolysis of vicilin^d and of the legumelin of peas;^e the viginin of the cowpea (*Vigna sinensis*);^f the hydrolysis of vitellin from the hen's egg;^g the hydrolysis of the muscle of scallop;^h the hydrolysis of crystallized albumen from hen's egg;ⁱ and the hydrolysis of ox muscle.^j

In a summary of the work with reference to the different forms of nitrogen, in proteins,^k some important deductions are included on determinations of the actual quantities of histidin, arginin, and lysin obtained in the cleavage products of protein which show that they vary markedly, particularly as to the yield of arginin and lysin and that proteids, "when arranged in the order of their yield of arginin,

^a Jour. Biol. Chem., 2 (1907), No. 4, p. 309.

^b Amer. Jour. Physiol., 23 (1908), No. 2, p. 81.

^c Carnegie Institution of Washington, Pub. 84.

^d Jour. Biol. Chem., 5 (1908), Nos. 2-3, p. 187.

^e Jour. Biol. Chem., 5 (1908), Nos. 2-3, p. 197.

^f Amer. Jour. Physiol., 22 (1908), No. 3, p. 362.

^g Ibid., 24 (1909), No. 1, p. 153.

^h Ibid., p. 161.

ⁱ Ibid., No. 2, p. 252.

^j Ibid., 24 (1909), No. 5, p. 437.

^k Ibid., 23 (1908), No. 3, p. 180.

fall into three groups. First the oil seeds, then the leguminous seeds, and finally the cereal grains, the only exception being the glutelin of maize, which is one of the least well characterized and studied of all the proteins in the list, and may be a mixture of several different proteins.

We have in the chemical constitution of these seed proteins [Professor Osborne states] an apparent relationship not only to the biological relations of the plants which produce them, but also to the chemical constitution of the seeds themselves.

Chamberlain's ^a work on wheat proteids should also be mentioned in this connection. In collaboration with Saiki, ^b he has also made interesting studies of the proteids of marine algæ, from which the practical conclusion is drawn that Irish moss in invalid diet is useful as a convenient vehicle for other materials rather than as having of itself great food value.

Jordan, Hart, and Patten, ^c and Mendel and Underhill, ^d have studied the occurrence of phytin in bran and its effects upon the animal organism. From its laxative and other physiological effects this substance is of importance in considering the value of the coarser milling products of wheat and other grains.

Hart and his associates ^e at the Wisconsin Station have continued the studies of the rôle of inorganic phosphorus in the nutrition of animals which was begun at the New York State Experiment Station, pigs being used as subjects. The results obtained as is the case with so many lines of experiment station investigations in which farm animals serve as subjects, are general in their purpose, and the results are applicable to physiological problems with human beings as well as with animals. It is pointed out in a discussion of the results obtained that—

The marked reduction on the quantity of ash of the bones of the animal receiving an insufficient supply of calcium phosphates, together with the ability of the animal to build up a skeleton very rich in calcium phosphate when an abundance of the latter is supplied in inorganic forms, strongly points to the possession of a synthetic power by the animal which enables it to convert inorganic forms of phosphorus into the organic forms demanded by its body.

Hart and his associates ^f have also reported data concerning the ash constituents of wheat bran in the metabolism of herbivora, and Hart and Tottingham ^g on the nature of the acid soluble phosphorus compounds of a number of important feeding stuffs.

^a Jour. Amer. Chem. Soc., 28 (1906), No. 11, p. 1657.

^b Jour. Biol. Chem., 2 (1906), No. 3, p. 251.

^c New York State Sta. Tech. Bul. 1; also Amer. Jour. Physiol., 16 (1906), No. 2, p. 268.

^d Amer. Jour. Physiol., 17 (1906), No. 1, p. 75.

^e Ibid., 23 (1909), No. 4, p. 246.

^f Ibid., 24 (1909), No. 1, p. 86.

^g Jour. Biol. Chem., 6 (1909), No. 5, p. 431.

Forbes,^a of the Ohio Experiment Station, has published two bulletins which have to do with ash constituents and their importance in the diet, namely, "The Mineral Elements in Animal Nutrition," and "The Balance Between Inorganic Acids and Bases in Animal Nutrition." These publications discuss the data from the standpoint of human nutrition as well as animal feeding.

Cook^b of the Bureau of Chemistry has also studied the metabolism of organic and inorganic phosphorus, and the work of Goodall and Joslin^c on ash-free diet is of interest and value in this connection.

The study of the respiration of apples and the relation to keeping quality reported by F. W. Morse^d of the New Hampshire Station may be mentioned as an example of experiment station work undertaken for a specific purpose, which is of interest also to students of nutrition. Other instances might be cited of similar work, notably studies of cereals, potatoes, and other crops, in relation to quality.

Though primarily undertaken from the standpoint of animal nutrition, Chamberlain's^e work at the Bureau of Chemistry on the feeding value of cereals furnishes data regarding composition of cereal grains, which is also interesting from the standpoint of human nutrition.

Milling and baking tests have been reported by a large number of investigators in the United States and Canada in connection with studies of different varieties of wheat, including durum wheats, Russian wheats, and other foreign varieties, as well as the kinds which have been more generally grown in the United States. In this connection mention should be made of the work of Waldron^f of the North Dakota Experiment Station, with a number of varieties, including Russian wheats; Stewart and Greaves^g studies with Utah wheats grown on irrigated and unirrigated lands, Thatcher's^h studies of the milling qualities of wheats, the work of Ladd and other investigatorsⁱ at the North Dakota Experiment Station, which had to do especially with durum wheats in comparison with other North Dakota wheats, and the work of Saunders and Shutt^j at the Canadian Experimental Farms with Manitoba wheats and with other varieties. In connection with the work at the North Dakota Station, samples of durum flour were sent out to a number of housewives in order that the bread-making qualities of this flour might be tested

^a Ohio Sta. Buls. 201 and 207.

^b U. S. Dept. Agr., Bur. Chem. Bul. 123.

^c Trans. Assoc. Amer. Physicians, 23 (1908), p. 92.

^d New Hampshire Sta. Bul. 135.

^e U. S. Dept. Agr., Bur. Chem. Bul. 120.

^f North Dakota Sta., Rpt. Dickinson Substa. 1908, p. 24.

^g Utah Sta. Bul. 103.

^h Washington Sta. Popular Bul. 6.

ⁱ North Dakota Sta. Bul. 82.

^j Canada Cent. Expt. Farm Buls. 57, 60; Canada Expt. Farms Rpts. 1907, p. 219.

in the home.^a In general, the results were favorable to durum flour, the consensus of opinion, according to the published report, being that: "The flavor of the bread is equal, if not superior, to that produced from the commercial flours, being slightly sweeter and having a more nutty flavor;" "The bread is not so white as that made from the average Fife or Bluestem flour, having more of a creamy appearance;" "The bread from durum flour holds the moisture better than that produced from the commercial flours;" [and] "The general consensus of opinion in testing the durum flour in bread making is that the bread is equal to that of other flours."

Several investigators have studied the changes which take place in wheat and in flour when it is stored. The investigations of Leavitt and LeClerc^b of the Bureau of Chemistry have to do with changes in the composition of ground and unground cereals during storage, and Bell^c has contributed interesting data on the changes which take place in stored flour. Investigations which have to do with this question, and particularly with the effects of storing moist wheat, have been reported by Saunders.^d

Few subjects connected with the chemistry of a staple article of diet have been more extensively studied than the character of wheat gluten, the estimation of gluten and its constituents, glutenin and gliadin, the relation of gluten constituents to bread making, the proportion of water which flour will absorb, and related topics. Mention should be made in this connection of Shaw's^e tests of a polariscopic method of determining gliadin, and Mathewson's^f studies of the estimation of gliadin. The very extended and important work of Osborne on the general subject of wheat gluten has been cited above. (See page 371).

COOKING AND ITS RELATION TO NUTRITIVE VALUE.

Considerable work has been done regarding the changes produced in foods by cooking, a subject which is of great importance in the consideration of nutrition problems and the practical application to everyday problems of the results of experimental investigations.

Grindley and his associates have continued their elaborate experiments on the cooking of meat. In collaboration with Miss Sprague he has published "A Precise Method of Roasting Meat,"^g in which

^a North Dakota Special Bul. 19.

^b Jour Indus. and Engin. Chem., 1 (1909), No. 5, p. 299.

^c Oper. Miller, 13 (1908), No. 12, p. 591; Bakers' Helper, 22 (1908), No. 260, p. 1132; Amer. Miller, 37 (1909), No. 4, p. 280.

^d Canada Expt. Farms Rpts. 1909, p. 206.

^e Jour. Amer. Chem. Soc., 29 (1907), No. 12, p. 1747.

^f Jour. Amer. Chem. Soc., 30 (1908), No. 1, p. 74.

^g Univ. Ill. Univ. Studies, 2 (1907), No. 4.

the insertion of thermometers into the interior parts of the meat is shown to be the only accurate method of controlling the extent of cooking, because the appearance and temperature of the outside are not reliable evidence, even to the experienced observer, of the temperature within. The data reported show that it is possible to obtain uniform results in the cooking of meats. As a whole, the investigations summarized are of great interest and value to the student as well as to the housekeeper.

Experiments were also made by Grindley and his associates as part of the extended investigations of the comparative composition and quality of fresh and cold-storage beef and fresh and cold-storage chicken, both drawn and undrawn. This work, which is extended and valuable, is referred to elsewhere. (See p. 369.)

Changes brought about by the action of heat on individual muscle fibers are of importance in discussing cooking problems, as it is the sum of these changes which in a large measure is accountable for the differences in texture between raw and cooked meat. A paper of interest in connection with studies of cooking meat was published by Meigs^a under the title "Concerning the Supposed Connection Between Protein Coagulation and the Heat Shortening of Animal Tissues."

Many cooking tests, which in some cases include records of cost and quantities, have been made by Miss Caroline Hunt at the Office of Experiment Stations in connection with studies of the economical use of meat in the home. The data obtained have been reported as part of an extended discussion of the problem recently published by this Office as a Farmers' Bulletin.^b

Various investigators have studied changes produced in starches during cooking, and a report on this subject by Prof. Edna D. Day^c has been published. Careful tests were made of the different forms of amylose and other constituents of various starch grains, and the amount of heat required to reduce them to a paste; their digestibility in different conditions was also tested artificially. The following practical conclusion is quoted here:

Increasing the proportion of diastase to starch in artificial digestion experiments markedly hastens the digestion of both blue and red amylose. It would appear, therefore, that eating starchy foods slowly, which would of course increase the proportion of saliva and ptyalin to a given quantity of starch, would be of more value from the standpoint of digestion than would any cooking of starch beyond the stage of paste formation.

A summary of much work with starches is found in a bulletin by Margaret J. Mitchell, entitled "Course in Cereal Foods and Their Preparation,"^d intended for class-room use, especially in the mova-

^a Amer. Jour. Physiol., 24 (1909), No. 1, p. 178.

^b U. S. Dept. Agr., Farmers' Bul. 391.

^c U. S. Dept. Agr., Office Expt. Stas. Bul. 202.

^d U. S. Dept. Agr., Office Expt. Stas. Bul. 200.

ble schools of agriculture, and interesting not only in itself but also as showing the high character of the work in nutrition done in such schools.

A paper by Crocker,^a of interest in connection with bread-making investigations, had to do with the cracking or checking of biscuits and crackers and its prevention. The subject was considered especially from the bakers' or manufacturers' standpoint.

Cooking tests should also be mentioned which were made under Miss Watson's^b direction at the Ontario Agricultural College to determine whether strong wheat or soft wheat is best suited for making baking-powder-milk biscuits. The effect on quality of mixing fat into dough in different ways was also studied.^c

In a report of the examination of baking powders on sale in Canada, McGill^d discusses the keeping quality of baking powder, the efficiency of different types as gas producers and related questions, and also reports determinations of the total, available, and residual gas, and of the excess of bicarbonate of soda in a number of different brands of baking powders.

Careful baking tests have been made at Teachers' College, New York, in cooperation with the Office of Experiment Stations, with different kinds of corn meal and different methods of preparation, the general conclusion being that corn ground by modern methods of grinding, which remove the germ and its abundant fat, must be mixed with different proportions of the other ingredients in making bread and be cooked under different conditions from those which have proved successful with old-fashioned meals. Brief summaries of this work have been published,^e but the data have not yet been reported in full.

The report of the Wisconsin Bakers' Institute^f should be noted, as it shows an intelligent desire on the part of bakers to cooperate in efforts which are being made under Wisconsin law to insure clean bakeries. The report discusses a variety of baking problems and contains a number of papers of general interest, among which may be mentioned *The Inner Structure of the Grain as Related to Flour and Bread*, by N. A. Cobb; *Fermentation in Bread Making*, by W. D. Frost, in which the question of malt extracts in conjunction with yeasts to improve fermentation, and similar problems are discussed; *Bake Shop Hygiene and Sanitation*, by M. P. Ravenel; and a similar paper by C. B. Ball.

^a Rpt. Ann. Meeting Biscuit and Cracker Manfrs. Assoc., 1908, p. 16.

^b Ontario Agr. Col. and Expt. Farm Rpt. 1908, p. 242.

^c *Ibid.*, 1907, p. 244.

^d Lab. Inland Rev. Dept. Canada Bul. 174.

^e U. S. Dept. Agr., Office Expt. Stas. Rpts. 1906, p. 33; 1907, p. 32.

^f Bien. Rpt. Bur. Labor and Indus. Stat. [Wis.] 1906-7, pt. 5.

In a study of the chemical nature of corn oil, by W. McPherson and W. A. Ruth,^a its possible use as an adulterant in lard, its detection, and culinary tests with corn oil and leaf lard mixtures are included.

CANNING AND PRESERVING.

Canning and preserving form a question which has interested a number of investigators. The Wisconsin Experiment Station has published a bulletin giving directions for canning and preserving fruits and vegetables, prepared by Mrs. Adams and E. B. Sandsten,^b and containing the results of experimental work with wild native fruits, and the North Carolina department of agriculture has issued a bulletin summarizing data on canning and preserving by McCarthy.^c Tonney and Gooken^d have studied the gases contained in so-called swollen canned goods.

Pernot^e at the Oregon Station studied the problem of canning mushrooms by domestic methods, and according to the results obtained they may be readily canned in their own liquor either in glass or tin by the methods commonly followed in canning fruits, the young mushrooms being best suited for the purpose. Sterilizing the cans at intervals for several days is recommended, a procedure which is in accordance with the general observation that fractional sterilization is a matter of great importance in successful canning.

At the Bureau of Chemistry, Department of Agriculture, Bitting^f studied the canning of peas and Breazeale of the same bureau has published a Farmers' Bulletin^g on canning vegetables in the home, which summarizes a large amount of useful information based on his own experiments.

At the University of Chicago, Mrs. Alice P. Norton and Miss Snow,^h cooperating with the Office of Experiment Stations, have studied the effect of different quantities of sugar and different methods of manipulation on the yield and quality of jelly and the effects of temperature on the sugar and acid contents of fruits. The data have recently been reported by Miss Snow. In general, Miss Snow found that the yield of jelly was directly proportional to the amount of sugar used, though jelly made with sugar and fruit juices in the proportion of one

^a Ohio Dairy and Food Com. Rpt., 1906, p. 18; Jour. Amer. Chem. Soc., 29 (1907), No. 6, p. 921.

^b Wisconsin Sta. Bul. 136.

^c North Carolina Dept. Agr., Biol. Div., 1907.

^d Amer. Food Jour., 3 (1908), No. 6, p. 20.

^e Oregon Sta. Bul. 98.

^f U. S. Dept. Agr., Bur. Chem. Bul. 125.

^g U. S. Dept. Agr., Farmers' Bul. 359.

^h U. S. Dept. Agr., Office Expt. Stas. Rpt. 1907, p. 29; Jour. Home Econ., 1 (1909), p. 261.

to two seems to keep as well as that made with sugar and juices one to one. With the smaller amount of sugar the fruit flavor was more pronounced. In the tests undertaken to determine the effects of sugar added before and after the cooking period, it was found that cane sugar cooked with apples was largely inverted; when added at the close of the cooking period, it was slightly inverted; and although the invert sugar is less sweet than cane sugar, yet the difference in sweetness between stewed apples when the sugar has been added before and after cooking, respectively, is so slight as to be of little practical consequence. Edna D. Day^a has also reported results of tests which have to do with these questions and confirm Miss Snow's results.

Nellie E. Goldthwaite, of the University of Illinois,^b has reported results of an extended study of the chemistry and physics of jelly making. According to Miss Goldthwaite, the essential things in fruit juice are, first, pectin and, second, acid, a desirable constituent being cane sugar, though jelly can be made without it. Too much sugar, she concludes, is likely to cause a deterioration in the quality of jelly.

The physical constants of hot juice ready to jelly on cooling are, substantially, boiling point 103° C., and specific gravity 1.28.

Jelly making seems to consist in so controlling conditions by means of acid and sugar and boiling as to cause the pectin to be precipitated in a continuous mass throughout the volume allotted to it.

With respect to the necessity of the presence of acid in jelly making a number of tests were carried on in which citric acid or tartaric acid, organic acids which normally occur in fruit juices, were used in different proportions. The results showed that with added acids it is possible to make jellies of good texture from such fruits as peaches and pears, though in the case of peaches the characteristic peach flavor was not retained.

At the Florida Experiment Station, Belling^c studied guava jelly making under a variety of conditions. According to his results, a preliminary heating of the fruit is essential, as juice expressed from the raw fruit did not flow readily, and though it gave a light, amber-colored jelly with the proper proportion of sugar, with or without citric acid, yet the characteristic guava flavor was entirely lacking. The juices from heated fruit pass through the filtering cloth more readily than that from raw fruit, and the heating also seems to help in extracting the fruit flavor.

The flavoring quality does not appear to reside in the oil glands of the rind. * * *

In the boiling of guava jelly some acid (the natural acid of the ripe fruit) is absolutely necessary to change much of the sucrose into invert sugar, and if this does not take place then the sucrose crystallizes out. Too much acid (and probably too pro-

^a Jour. Home Econ., 2 (1910), p. 94.

^b Jour. Indus. and Engin. Chem., 1 (1909), p. 333.

^c Florida Sta. Rpt. 1908, p. CV.

longed boiling) seems to make the jelly sticky from the excess of invert sugar, and also to alter the pectin so that it will not gelatinize.

The pink color of guava jelly does not seem to depend on any pink color in the flesh of the fruit, though the white guavas yield a lighter jelly. The depth of color seems to be increased by additional amount of acid, prolonged boiling, and higher temperature at which the boiling is stopped.

G. W. Shaw, of the California Experiment Station,^a has studied the comparative value of beet sugar and cane sugar for canning and jelly making, and finds there is no difference when sugars are of the same grade. The same publication reports studies of the possibility of marketing prunes in cans, which led to the conclusion that when thus packed they would keep indefinitely without sugaring.

The general subject of handling and caring for food in the home has been discussed in a Farmers' Bulletin by Mrs. Mary Hinman Abel,^b and the subject of caring for canned goods of domestic and commercial manufacture is discussed together with other related topics.

Dehydration or evaporation has long been followed as a method of preserving fruits, meat, and vegetables, and in recent years the process has been greatly improved and applied to other materials. Dent,^c of the Navy Department, reports the results of a test of such goods in the United States Navy. He found that dehydrated eggs and a majority of the dehydrated fruits and vegetables studied gave good results, but the powdered milk was not so satisfactory. Some information is also given by Dent regarding the quantity of dehydrated material required in comparison with fresh goods.

Booth,^d in a paper on desiccated milk, describes the process of manufacture of such goods and gives analyses for a number of commercial products containing varying amounts of fat, corresponding to the use of skimmed or partially skimmed milk for evaporating.

LABOR-SAVING DEVICES AND HOME CONVENIENCES.

Much interest has been shown in fireless cookers and the question of their practicability. The report of severe tests made by the Commissary-General's Office of the War Department^e describes the special form developed for army use as a simple and durable means of furnishing hot, well-cooked meals to troops under adverse conditions. A number of experimental studies with the fireless cooker have been reported from the University of Wisconsin by Ellen A. Huntington,^f which had to do with the relative merits of materials

^a California Sta. Circ. 33.

^b U. S. Dept. Agr., Farmers' Bul. 375.

^c Navy Department, Bur. Supplies and Accts., Mem. Inform. Off. Pay Corps [etc.], No. 85, p. 626.

^d Spice Mill, 31 (1908), No. 10, p. 620.

^e War Dept. [U. S.], Rpts. Commis. Gen., 1906-1909.

^f Bul. Univ. Wis., No. 217.

and methods of construction and with the efficiency of the fireless cooker for the preparation of food. At least two books have been published devoted to the use of the fireless cooker, both of which are based on the experience of the writers—namely, the books by Caroline B. Lovewell, Francis D. Whittemore, and Hannah W. Lyon,^a and by Margaret J. Mitchell.^b

In a discussion of cooking the cheaper cuts of meat by C. Barnard,^c the subject is considered particularly with reference to the use of the fireless cooker, which, in the author's opinion, is efficient, economical, and convenient.

Popular articles^d with practical descriptions of inexpensive home cookers are also numerous and are important as pointing out means of simplifying household work.

The question of labor-saving devices has been discussed by Le Bosquet,^e who summarizes a great deal of valuable data regarding kitchen appliances, laundry appliances, alcohol and electricity for cooking, and other topics. The bulletin as a whole is a summary of information based on careful tests and other data.

Barnard,^f at his experimental housekeeping station, has studied the use of alcohol as a source of light and as a fuel for household purposes, the use of the fireless cooker and of various household conveniences and labor-saving devices.

The convenient equipment of rural schoolhouses for teaching cookery is also considered by Barnard.^g

THE STORAGE OF FOOD AND ITS RELATION TO QUALITY AND NUTRITIVE VALUE.

Changes in the character of food materials during storage have been the subject of much discussion recently, but mainly in connection with pure-food work.

Studies of the chemical changes taking place in the ripening of fruits, such as oranges and persimmons, and also during storage, have been conducted by W. D. Bigelow and his collaborators of the Bureau of Chemistry,^h and have much interest and value in discussions of nutrition problems from the relation of such changes to table quality.

^a *The Fireless Cooker*. Topeka, 1908.

^b *The Fireless Cookbook*. New York, 1909.

^c *Housekeeping Experiment Station (Conn.) Bul.* 6.

^d *The Hay-box Cookbook*. Chicago, 1906. *The Hay-box Cooker*. Cornell Reading Course for Farmers' Wives, 5. ser., No. 23, p. 446. *Amer. Agr.*, 79 (1907), No. 1, p. 27. U. S. Dept. Agr., *Farmers' Bul.* 296, p. 16.

^e *Bul. Amer. School Home Econ.*, ser. 1, 1908, No. 11.

^f *Housekeeping Expt. Sta. (Conn.) Buls.* 1, 2, 3, 4, and 6.

^g *Ibid.*, *Bul.* 5.

^h *Jour. Amer. Chem. Soc.*, 28 (1906), No. 6, p. 688, and 29 (1907), No. 5, p. 767.

Various writers have reported experiments with refrigerated beef, and some of the data are of special interest to students of nutrition. From their studies of frozen beef Richardson and Scherubel^a concluded that decomposition did not take place in meat thus stored for six hundred and ten days, and that in flavor it did not differ from that of fresh beef. A general conclusion reached is that cold storage below -9° C. is an adequate and satisfactory method for the preservation of beef for at least five hundred and fifty-four days. They further concluded that freezing meats from -9° to -12° C. arrests bacterial decomposition, though naturally freezing can not restore tainted meat to its original condition.

Grindley and his associates^b have studied the effects of cold storage on composition and quality of raw and cooked beef and chicken; they concluded that fresh and frozen drawn and undrawn fowls differed little in composition and nutritive value when considered on the basis of a uniform fat and water content. As regards the juiciness and flavor of the cooked beef the evidences of the experimental data, they concluded, are in favor of the cold-storage product. (See also p. 369.)

The question of drawn and undrawn poultry kept in cold storage was also studied by Boos^c in connection with the Massachusetts State Board of Health. From his experimental studies Boos concludes that—

it is best to draw fowl in a different manner from that usually followed, before they are placed in cold storage. After removal from cold storage the fowl should never be contaminated by soaking in water, but should thaw in the air. Ordinary drawing is worse by far than no drawing at all.

According to Brown's^d investigations—

decomposition depends largely upon the presence of moisture in the tissues, for moisture is absolutely essential to bacterial growth. In freshly killed birds, ordinarily or properly drawn, the surfaces quickly become dry. In cold-storage birds, no matter how they are drawn, the tissues will be moist, because of the melting of the crystals of ice. If properly drawn, there would be but few bacteria present capable of causing decomposition.

Similar investigations were carried on by Bissell^e under the auspices of the Buffalo department of health, and the effects of cold storage studied with drawn and undrawn turkeys. He concluded that when stored for a year no change had taken place which made the food detrimental to health, provided it was in proper condition

^a Jour. Amer. Chem. Soc., 30 (1908), No. 10, p. 1515; Jour. Indus. and Engin. Chem., 1 (1909), No. 2, p. 95.

^b Jour. Indus. and Engin. Chem., 1 (1909), No. 7, p. 413; No. 8, p. 580.

^c Ann. Rpt. Bd. Health Mass., 1907, p. 263.

^d Ann. Rpt. Bd. Health Mass., 1907, p. 285.

^e Buffalo [Dept. Health], 1909; Ann. Rpt. Dept. Health Buffalo, 1908, p. 34; Buffalo [Dept. Health] Sanit. Bul., n. ser., 2 (1909), No. 3.

when placed in storage. He also notes that when turkeys are stored undrawn there is a tendency for the odor, and undoubtedly the taste, of the material contained in the intestines to permeate the adjacent tissues at the time of the thawing-out process. There is also the possibility of the bacteria contained in the intestinal contents migrating through the abdominal tissues at the same time. He believes, therefore, that the poultry should be properly drawn before storage.

The extended investigations on cold storage of poultry and other foods carried on by the Bureau of Chemistry of the Department of Agriculture have contributed much of the value to the subject of the quality and nutritive value of such goods.

In a report on the effects of cold storage on eggs, quail, and chickens, which was made by Wiley and his associates,^a losses in weight during storage, changes in chemical character, and related topics were considered. The general conclusion reached is that in the case of frozen birds—

there is no indication of any improvement in quality—that is, in taste, odor, or flavor, during cold storage. There is a deterioration, which is noticeable, even at the end of three months, and becomes more marked as the time of storage grows longer. Hence, without any reference whatever to the question of wholesomeness, cold storage prolonged for six months or more appears to be distinctly detrimental as far as taste, flavor, and palatability are concerned.

The intestines which are left in situ in storage birds show a very marked degeneration. Their muscular walls grow thinner in cold storage until they are the merest remnants, which threaten to disappear altogether and which even very careful handling may easily rupture. This degeneration is noticeably active in the muscular rather than in the cellular tissues of the intestines. This is important when it is considered that the bacterial flora of the intestinal contents will, of course, contain any pathogenic germs which usually accompany the colon bacillus. Hence the perforation of the walls of the intestines, which apparently takes place by continued digestive processes even in cold storage, would open the way for a rapid migration of such bacteria on thawing and previous to cooking. Thus it is quite possible that dangerous bacterial organisms might be translated to the edible portions of the fowl through the perforations of the intestines in the period between thawing and cooking. This degeneration of the walls of the intestines must therefore, be regarded as highly significant.

Of studies of the changes which take place during cold storage, mention should be made of the work of Miss Pennington^b of the Bureau of Chemistry, of which a portion has been summarized in an article on the changes taking place in chickens in cold storage in the Yearbook noted above. In the light of her investigations she writes:

The dictum of the warehouseman that there is no change in cold-storage poultry, and that it may be kept for an indefinite period, can not be accepted in its entirety.

^a U. S. Dept. Agr., Bur. Chem. Bul. 115.

^b U. S. Dept. Agr., Yearbook 1907, p. 197.

FOODS AND THEIR RELATION TO PROBLEMS OF HYGIENE.

The investigations on cold storage summarized in the preceding section have an important bearing on hygiene, as is evidenced from the data to which reference has been made. That the whole question of food in relation to hygiene is a subject of much interest at the present time is shown by the extent of the published work which bears upon the subject.

Two widespread diseases are commonly said to have some connection with cereal grains—namely, beriberi, which is a very common occurrence in Java and other eastern countries, and which is commonly associated with rice, and pellagra, which is by many investigators believed to have some connection with the use of Indian corn. Both diseases are well characterized and have been the subject of a large amount of investigation, yet in neither case is the problem solved. Both pellagra and beriberi have been attributed to specific micro-organisms accidentally conveyed, respectively, by corn and by rice; to some characteristic of the proteids present in these cereals, to a deficiency in ash, or some specific characteristic of the ash constituents of the grain. Undernutrition has likewise been held by many to be an important contributing cause. A theory which finds much to support it attributes pellagra to a parasite conveyed by the agency of an insect bite.

As yet it has not been necessary for American investigators to take up the question of beriberi; but, on the other hand, the reporting of cases of pellagra in different parts of the United States has led a number of American investigators to study this disease with special reference to the theory often advanced that it is in some way connected with the use as food of spoiled Indian corn. This subject is being investigated by the United States Public Health and Marine-Hospital Service, and among other papers, mention should be made of the extended summary of Lavinder.^a It seems apparent from this and other work that pellagra is most usually found among persons who are or have been poorly nourished and among those who are, for this or some other reason, thought to be less resistant to diseases than persons in better physical condition. Perhaps, for this reason, pellagra has been particularly noticeable in asylums for the insane and similar institutions. One of Lavinder's general deductions was that under the circumstances Indian corn should be omitted from the dietary of such institutions, and until its cause has been definitely ascertained he considers that the use of corn in the home is to be regarded as an open question which each individual must settle for himself.

^a Pub. Health and Marine-Hosp. Serv. U. S., 1908; N. Y. Med. Jour. and Phila. Med. Jour., 90 (1909), p. 54.

In a discussion of the subject Alsberg,^a of the Bureau of Plant Industry of the Department of Agriculture, considers the possible connection between pellagra and the marketing of immature or imperfectly cured corn, believing that such corn would be especially favorable for the growth of micro-organisms. He also believes that varieties of corn with a small proportion of germ should be cultivated, as the high proportion of fat in the germ is also regarded as a favorable condition for the growth of certain types of micro-organisms.

Pellagra, with special reference to dietetics in public institutions, has been studied by Buhlig,^b Siler, and Nichols^c at a state hospital for the insane in Illinois, but final conclusions have not as yet been reached. In the report of this work it is pointed out that the corn used in the institution diet was of good quality, and, moreover, that it did not constitute any large proportion of the institution diet. In connection with studies of moldy corn, cooked as well as raw corn was included, since some molds are known to be very resistant to heat and the idea has been advanced that molds or other micro-organisms might survive the heat of cooking and be the cause of disease. According to the report, a few experiments were made with corn-meal mush and hominy made in the usual way at the institution by boiling about two hours. "We can not see how anything living can withstand such treatment and our two cultures of corn meal and two of hominy on gelatin bore us out by being sterile after several weeks."

Various questions which have to do with sanitation of food manufacturing, bake shops, and markets, and with the general subject of food adulteration or use of preservatives and related questions, may also be appropriately mentioned in this connection. The national pure-food work is centered in the Bureau of Chemistry of the Department of Agriculture, while that carried on in individual States is very generally assigned to the agricultural experiment stations or to state boards of health. The subject is so large and the work reported is so extended that any adequate consideration of it would require a special summary. A matter of great importance in connection with the hygiene of foods is meat inspection. The Bureau of Animal Industry of the Department of Agriculture is charged with the carrying on of the federal meat-inspection service, and the subject is considered in publications of the Bureau. In an article by Farrington^d it is urged that such inspection should be extended to include the meat slaughtered for local consumption and therefore not subject to federal inspection, since it is not designed for interstate commerce.

^a N. Y. Med. Jour. and Phila. Med. Jour., 90 (1909), p. 50.

^b Mo. Bul. Ill. Bd. Health, 5 (1909), No. 7, p. 417.

^c Mo. Bul. Ill. Bd. Health, 5 (1909), No. 7, p. 437.

^d U. S. Dept. Agr., Bur. Anim. Indus. Rpt. 1909, p. 82.

Those who are interested at all in the meat inspection in general and the discussion of what may be classed as diseased meat from the standpoint of hygiene and dietetics will find a large amount of valuable data in recent papers by Theobald Smith.^a

Much interest has been aroused by the publication of Metchnikoff's data on special lactic acid-forming ferments as an intestinal disinfectant, and on the relation of intestinal fermentation and the general subject of health. Mention may be made in this connection of the published summary by Metchnikoff which has appeared in the *Century Magazine* for November, 1909. The question is being studied by many investigators, and it is worthy of note that the results obtained are not uniformly in accord with Metchnikoff's conclusions. From the interest which the subject has aroused, it seems probable that before many years have passed so much experimental evidence will be available that the whole subject will be thoroughly understood.

Of recent American studies which have to do with intestinal putrefaction may be mentioned Herter's paper on *The Therapeutic Action of Fermented Milk*,^b *The Fecal Bacteria of Healthy Men*, by MacNeal, Latzer, and Kerr, which formed a part of extensive studies of meat carried on at the University of Illinois,^c and *Some Observations on the Study of the Intestinal Bacteria*, by Kendall.^d

DIETARY STUDIES.

During the period included in this summary a considerable number of dietary studies have been carried on by the Office of Experiment Stations,^e of which the bulk have been published, though a number made in schools still await publication. In a bulletin reporting the results of dietary studies in rural regions, J. L. Hills, Charles E. Wait, and H. C. White^f reported, respectively, 4 studies with farmers' families in Vermont, 64 in the mountains of Tennessee, and 14 in Georgia, together with a few others made for purposes of comparison. As a whole, the bulletin supplies a large amount of statistical and other data regarding living conditions in rural regions, particularly those remote from large centers of population, where conditions are very different from those prevailing in towns, cities, and farms which are otherwise situated. A bulletin has also been published reporting investigations in public institutions by Miss Emma Smed-

^a *Amer. Jour. Pub. Hygiene*, 19 (1909), No. 2, p. 397. *Mo. Bul. Mass. State Bd. Health*, n. ser., 4 (1909), No. 10, p. 220.

^b *Pop. Sci. Mo.*, 74 (1909), No. 1, p. 31.

^c *Jour. Infect. Diseases*, 6 (1909), No. 2, p. 123.

^d *Jour. Biol. Chem.*, 6 (1909), No. 6, p. 499.

^e U. S. Dept. Agr., Office Expt. Stas. Rpt. of Director, 1906, p. 37; 1908, p. 28.

^f U. S. Dept. Agr., Office Expt. Stas. Bul. 221.

ley, R. D. Milner, H. L. Knight, H. A. Pratt, and C. F. Langworthy,^a in Baltimore and Philadelphia, namely, in homes for the aged and orphan asylums, including institutions under municipal and private management. The studies were undertaken with a view to securing additional data regarding food requirements of the aged and of young children, and also to demonstrate the desirability of using nutrition methods in the study of institution problems from the standpoint of institution interests. Mention may also be made of the publication of "Food and Diet in the United States,"^b which gives a general summary of data with recommendations for dietary standards in terms of food purchased, food eaten, and food digested, and which also includes estimates of the amounts of the principal mineral constituents of the diet required per man per day.

The reports of the President's Homes Commission,^c which was appointed to study conditions of the District of Columbia, contains several papers on food for wage-earners' families and related topics.

Dietary studies made during a four weeks' walking trip were reported by H. L. Knight,^d which are of interest, as the majority of the foods selected were of the type which supply nutritive material in small bulk.

W. M. Hays and E. C. Parker^e in a study of the cost of producing farm crops include interesting data regarding the kind and cost of food in Minnesota farm homes, accumulated with a view to determining the cost of farm board. Additional data on the subject are reported and discussed in a paper on the factors and cost of board on Minnesota farms by T. P. Cooper.^f These reports furnish much information regarding dietary conditions in farm homes in the regions selected for study.

The reports of the Commissary-General of the U. S. Army contain data regarding rations for different purposes, and various other publications which have appeared, contain data of interest regarding diet and dietary conditions in the United States, which it does not seem essential to summarize here.

In this connection mention may however be made of information summarized by Clark,^g Department of Commerce and Labor, regarding the food habits of Mexican laborers in the United States; the data reported by Miss Agnes Hunt^h of the University of Illinois, regarding

^a U. S. Dept. Agr., Office Expt. Stas. Bul. 223.

^b U. S. Dept. Agr., Yearbook 1907, p. 361.

^c 60th Cong., 2d sess., Sen. Doc. No. 644; also included in Reports of the President's Homes Commission, Washington, D. C., 1908, pt. 5.

^d Connecticut Storrs Sta. Rpt. 1905, p. 143.

^e Minnesota Sta. Bul. 97; U. S. Dept. Agr., Bur. Stat. Bul. 48.

^f Jour. Home Econom., 1 (1909), p. 43.

^g Bur. Labor [U. S.] Bul. 78, p. 466.

^h Ill. Agr., 12 (1908), No. 5, p. 146.

the food served in a students' boarding club, and a summary of data regarding food conditions and diet in the Philippines.^a The question of Filipino diet has been much more adequately discussed by H. Aron^b on the basis of personal observations and investigations. The general conclusion which he reached was that per kilogram of body weight, or better, per square meter of body surface, the Filipino obtains from his diet, which is composed largely of fish, beans, rice, and fruits, and some vegetables, very much the same quantity of protein and energy as the average American or European from his ordinary diet.

A dietary study of a students' boarding club, which covered one month, was carried on at the Institute for Colored Youth and Teachers' Training School at Cheyney, Pa.,^c a school under the management of the Society of Friends. The results show that the food supply was adequate, reasonable in cost, and that improvement in weight, capacity for work, and in general conditions was noticeable in the pupils, which was ascribed by those reporting the work to the generous diet which the school provides. The report also gives the menus for a school year.

THE DIET OF CHILDREN AND SCHOOL LUNCHES.

The question of school lunches has often been discussed during the last few years, and many contributions have been made to the subject, particularly those offering the suggestions as to the kind and character of food which should be provided and also regarding the possible danger of undernourishment of children in thickly congested districts and the desirability of organized attempts to meet the situation by supplying lunches. The dietary studies made under the auspices of this Office of orphan asylums have been already referred to. Of work which has to do particularly with the school lunch problem may be mentioned an account of cooking and serving a 5-cent lunch in the Honolulu Normal School by Marion Bell,^d and an account of serving hot lunches in 12 schools reported in the Annual Report of the Women's Educational and Industrial Union.^e

Caroline L. Hunt has published through the United States Bureau of Education^f an important monograph on the subject of diet for school children, which summarizes the bulk of the work hitherto published and makes a number of recommendations and deductions.

^a Jour. Home Econom., 1 (1909), p. 171.

^b Philippine Jour. Sci., B. Med. Sci., 4 (1909), pp. 195, 225.

^c Daily Menus for the School Year and a Dietary Study for October, Cheyney, Pa., 1909.

^d Boston Cooking School Mag., 12 (1908), No. 6, p. 292.

^e Ann. Rpt. Women's Ed. and Indus. Union, 29 (1909).

^f Bur. of Ed. [U. S.] Bul. 3, 1909.

Sill's^a experimental study of malnutrition in the school child in New York City deserves special mention, as it records experimental data. An improvement in health and general condition, it is stated, was observed when living conditions were made more hygienic and the children were given a generous diet.

The Starr Center Association^b in Philadelphia has published reports describing the movement which has resulted in supplying penny lunches to children in a number of schools in thickly congested districts.

COST OF LIVING AND OTHER SOCIOLOGICAL DATA.

Doubtless owing to the increased cost of food and other necessities, not only in the United States but in most countries, more attention than usual has been paid during the last year and a half to the cost of living and reports on this subject have been quite numerous. Among other papers may be mentioned a study of the cost of living in New Jersey.^c

Data on these topics are also included in a report on retail prices of food, 1890 to 1907, published by the United States Bureau of Labor.^d As the subject is one which is so extended that it requires independent treatment, no attempt will be made here to summarize the numerous similar articles which have appeared in bulletins, periodicals, and other publications.

A number of sociological studies of workingmen's families which include food and nutrition topics and other data have appeared, including Chapin's^e study of living conditions in wage-earners' families in New York City. Similar work with farmers' families, carried on by the Minnesota Experiment Station in cooperation with the Department of Agriculture, has been referred to elsewhere. (See p. 386.)

DIGESTIBILITY OF FOOD.

During the period included in this summary numerous studies have been made of the thoroughness of digestion of foods under a variety of conditions.

Many of the experiments made to determine the digestibility of food materials were carried out as special investigations, while some were made in connection with studies of other problems. Thus, Grindley's^f important work on the digestibility of meats of different

^a Jour. Amer. Med. Assoc., 52 (1909), No. 25, p. 1981.

^b Starr Center Assoc. [Rpt.], 1909, p. 18.

^c Ann. Rpt. Bur. Statis. Labor and Indus. N. J., 30 (1907), p. 141.

^d Bur. of Labor [U. S.], Bul. 77, p. 181.

^e The Standard of Living among Workingmen's Families in New York City, New York, 1909.

^f U. S. Dept. Agr., Office Expt. Stas. Bul. 193.

kinds and cooked in different ways was done along with the cooking experiments already referred to. A total of 99 artificial digestion experiments and 67 natural digestion experiments was made, and the general conclusions drawn were that the differences in digestibility between different kinds and cuts of meat or the same cuts cooked in different ways are much smaller than is commonly supposed, all showing high percentages of digestibility.

In 16 experiments with healthy men R. D. Milner^a tested the digestibility of fish and poultry, finding that the proportions of nutrients and energy assimilated were much the same as with other animal foods.

Experiments with healthy men to determine the digestibility of cheese prepared with different amounts of rennet and cured for different lengths of time were made by F. G. Benedict, and with Swiss, Camembert and Roquefort cheeses by H. Snyder, at the Minnesota Agricultural Experiment Station, in cooperation with the Bureau of Animal Industry and the Office of Experiment Stations, but the results still await publication in full. A brief summary^b of the work states that in general the results show that the different kinds of cheese vary but slightly in nutritive value and that all are thoroughly digested, even when eaten in considerable quantities.

Of investigations undertaken in connection with medical work, but of interest to students of nutrition, H. C. Carpenter's^c studies of the nutritive value of buttermilk, particularly for infants, and Walls's^d studies of the digestibility of the proteids of cows' milk in infancy, and similar papers, may be cited.

The digestibility of corn (maize) products prepared in different ways has been studied by C. D. Woods and his associates.^e

The differences in the coefficients of digestibility of corn products when eaten by healthy men in simple but appetizing diets were found to be only a fraction of a per cent less than those obtained for wheat bread, variations too slight to be of practical importance. The experiments on the digestibility of hulled corn by Merrill, of the Maine Station, have already been referred to (page 367).

Merrill^e also reports studies of the digestibility of chestnut flour. At the Sheffield Scientific School of Yale University, Saiki^f studied the digestibility of raw chestnuts, particularly raw chestnut starch. His results showed that this material is relatively indigestible. This work of Saiki was undertaken in connection with an investigation of some

^a Connecticut Storrs Station Rpt. 1905, pp. 116-142.

^b U. S. Dept. Agr., Office Expt. Stas., Rpt. of Director, 1906, p. 44.

^c Jour. Amer. Med. Assoc., 48 (1907), No. 19, p. 1576.

^d Jour. Amer. Med. Assoc., 48 (1907), No. 17, p. 1389.

^e Maine Sta. Bul. 131; U. S. Dept. Agr., Farmers' Bul. 298.

^f Jour. Biol., 2 (1906), No. 3, p. 251.

polysaccharid carbohydrates derived from lichens and marine algæ, including among others Iceland moss (*Cetraria islandica*), Irish moss (*Chondrus crispus*), and agar-agar. His data indicate that these substances which have been considered important food products are assimilated only to a limited extent. On the other hand, the algæ may be a valuable addition to the diet as they induce copious feces.

A painstaking study of the digestibility of legumes has been made by C. E. Wait.^a Healthy men were fed with mixed diets, including cooked dried legumes in common use in the Southern States, and the coefficients of digestibility for the legumes alone was calculated. The average results for protein ran from 70 to 83 per cent, and for carbohydrates from 87 to 96 per cent. The legumes seemed also to decrease slightly the digestibility of the total ration.

The food value of fruit and nuts has been studied by M. E. Jaffa in California, and their digestibility determined when eaten by healthy persons in a mixed diet. In 25 digestion experiments both classes of food appear to be thoroughly digested. In California, at least, they appear to be reasonably economical constituents of the diet, even in large amounts. The results of earlier experiments^b and later data not yet reported in full have been summarized in popular bulletins.^c

Numerous studies of the digestibility and other matters concerning the nutritive value of bleached flour have been studied at the Minnesota, North Dakota, and Nebraska experiment stations,^d and elsewhere. This work was undertaken in connection with the general subject of pure food legislation, a topic which should receive independent treatment in order to summarize it at all adequately, and so further reference will not be made to it here.

SPECIAL STUDIES OF PROTEIN AND OTHER FOOD CONSTITUENTS.

Among investigations along the lines of protein metabolism may be mentioned those of P. A. Schaffer,^e who studied the protein metabolism of healthy men in connection with diminished muscular activity and reports that

with sufficient food either an increase or a decrease of muscular activity within physiological limits has per se no effect upon the protein metabolism as indicated by the nitrogen and sulphur partitions in the urine.

In studying the nutritive value of gelatin, J. R. Murlin^f found that "the lower the general proteid condition of the body becomes the

^a U. S. Dept. Agr., Office Expt. Stas. Bul. 187.

^b U. S. Dept. Agr., Office Expt. Stas. Buls. 107, 132.

^c U. S. Dept. Agr., Farmers' Buls. 293, 332.

^d Report on Bleaching of Flour, H. Snyder, St. Anthony Park, Minn., 1906; Minnesota Sta. Bul. 111; North Dakota Sta. Spec. Bul. 9; Nebraska Sta. Bul. 102.

^e Amer. Jour. Physiol., 22 (1908), No. 4, p. 445.

^f Amer. Jour. Physiol., 19 (1907), No. 3, p. 285; 20 (1907), No. 1, p. 234.

more strongly does the organism lay claim to gelatin as a means of protecting its living substance," and that when taken with abundant carbohydrates glycocoll appears to be retained temporarily, if not permanently, by the body.

Folin^a has continued his work with the products of proteid cleavage, especially with the metabolism of creatin and creatinin. He summarizes his conclusions as follows:

There is no experimental evidence showing that creatin is the immediate precursor of the creatinin appearing in the urine. Biologically, there seems to be a fundamental difference between creatin and creatinin. * * * In the author's opinion it is not yet clear whether creatin is a waste product or a food.

F. G. Benedict and V. C. Myers^b also studied the elimination of creatin and creatinin with women in an insane asylum; they conclude that the creatinin output is less in women than in men, increases with age, and is probably proportional to body weight rather than to the active mass of protoplasmic tissue.

Lusk's^c paper on the specific dynamic effect of protein is of decided interest. On theoretical grounds he believes—

that the specific dynamic effect of protein is due to cleavage which involves the breaking down of the amid radical. If protein is resorbed rather than broken down, such cleavage does not take place and no specific dynamic effect is noted.

H. C. Sherman,^d who has conducted a series of studies which contribute much to the knowledge of the rôle of iron in food and in the human body, investigated the amount of iron in the body, its occurrence in ordinary mixed diet, and in two special dietary studies, besides conducting three metabolism experiments to determine the income and outgo of nitrogen, iron, phosphorus, calcium, and magnesium. It was found that the iron of the diet could be easily increased without increase of protein by the use of vegetables, fruits, and the coarser mill products of cereals, especially when accompanied by milk.

In cooperation with J. E. Sinclair^e he has further studied the balance of acid-forming and base-forming elements in food, calculating the amount of each element found to the corresponding number of cubic centimeters of the normal solution of acid or base.

By then adding together the results obtained it is easy to compare the totals, and the result obtained shows the excess of acid-forming or of base-forming elements in terms of a familiar standard and in figures of convenient magnitude.

^a Brit. Med. Jour., 1906, No. 2399, p. 1787. Upsala Läkarefö. Förhandl., n. ser., 11 (1906), Sup. III.

^b Amer. Jour. Physiol., 18 (1907), No. 4, p. 377.

^c Zentbl. Physiol., 21 (1907), No. 26, p. 861.

^d U. S. Dept. Agr., Office Expt. Stas. Bul. 185; Proc. Soc. Expt. Biol. and Med., 4 (1906), 2, p. 21; Chem. Abs., 1 (1907), No. 5, p. 582.

^e Jour. Biol. Chem., 3 (1907), No. 4, p. 307.

The value of such a method in questions connected with acidosis is obvious.

In a paper entitled "The mineral matter required by the human body," Sherman ^a summarizes the results of his investigations with iron referred to above and of similar studies with calcium and phosphorus carried on in cooperation with the Office of Experiment Stations, which are not yet reported in full. The data are summarized and discussed with special reference to the kinds and amounts of mineral matter required by the human body. From a comparison of the computed amounts of ash constituents supplied by 20 American dietaries selected as typical with the results of available metabolism experiments it appears, according to the author, that the amount of iron in the diet runs approximately parallel to the amount of protein, and that there is usually neither greater nor less likelihood of deficiency of the one than of the other. In the case of lime, however, the variations in the individual dietaries were much greater, and in nearly half the cases selected for comparison the diet appeared to furnish less lime than was required for the maintenance of equilibrium in many of the metabolism experiments carried on by the author. In the case of phosphorus nearly one-third of the dietaries summarized appeared to be deficient when judged by the results of the metabolism experiments.

From this it would appear that in the selection of food and in the planning of dietaries at least as much attention should be paid to the amount of calcium, phosphorus, and iron as to the amounts of protein. In many cases the dietary may be readily improved with respect to the ash constituents by the substitution of milk or cheese for a part of the meat and a freer use of fruits and vegetables in place of a part of the sugar and starch.

In experiments by H. W. Goodall and E. P. Joslin ^b an ash-free diet of specially prepared egg albumen, olive oil, and sugar was fed to two healthy men for thirteen and nine days, respectively. The results are said to give no support to the view that "the withdrawal of salts from the diet will cause an acidosis of the acetone variety."

Reference might be made to numerous physiological chemical studies, but the character and extent of the work is such that it deserves independent treatment.

DIETARY STANDARDS AND PHYSIOLOGICAL REQUIREMENTS.

Considerable discussion has followed the publication of the results of the elaborate work of Chittenden ^c and his conclusions that the best bodily condition is obtained by the use of a diet containing hardly more than one-half the protein called for by the commonly

^a Lake Placid Conf. Home Econ. Proc., 9 (1907), p. 114.

^b Trans. Assoc. Amer. Physicians, 23 (1908), p. 92.

^c *Physiol Econ. in Nutrition*: New York, 1904; *Nutrition of Man*: New York, 1907.

accepted standards. In his later volume the author upholds the position advanced in his earlier writings that the protein intake may be materially less than the usual dietary standard requires, and in his discussion of the question quotes the results of a number of experiments with dogs on what he considers a low proteid diet, in which the subjects maintained nitrogen equilibrium and body weight, or in some cases made slight gains. The author has incorporated in this volume the results of observations and experiments carried on during recent years, by himself and his associates, and discussed and summarized this work and other data with special reference to theories of nutrition. The subjects treated include foods and their digestion, absorption, assimilation, and the processes of metabolism, the balance of nutrition, the source of energy, of muscular work, with some theories of proteid metabolism, dietary habits, and true food requirements, as well as additional experiments and observations bearing on the subject of food requirements, and the effects of a low proteid diet on high proteid animals. Suggestions for the application of the author's theories and deductions are presented.

Extending the work carried on by Chittenden, Fisher ^a has made studies of low proteid rations with Yale students from which he has drawn similar deductions and interesting sociological conclusions.

F. G. Benedict ^b has also discussed the nutritive requirements of the body. Basing his deductions on the results obtained by the respiration calorimeter, he points out that the energy intake can be diminished safely only as the energy output, or the muscular activity, is lowered. He further cites facts from animal physiology and dietary conditions among different races of the world as indications that the protein standards can not with safety be greatly lowered.

S. C. Meltzer ^c has made another interesting and valuable contribution to this question. Starting with a comparison drawn from engineering that structures and machines are built to possess a strength or capacity beyond the usual demand upon them, he shows how—

all organs of the body are built on the plan of superabundance of structures and energy, [and denies that the single instance of food requirements] the minimum is meant by nature to be the optimum, [but maintains that] with regard to the function of supply of tissue and energy by means of proteid food, nature meant it should be governed by the same principle of affluence which governs the entire construction of the animal for the safety of its life and the perpetuation of its species.

^a Lake Placid Conf. Home Econ. Proc., 8 (1906), p. 76; Science, n. ser. 24 (1906), No. 620, p. 631; Yale Med. Jour., 1907, March; Trans. Conn. Acad. Arts and Sci., 13 (1907), p. 1.

^b Amer. Jour. Physiol., 16 (1906), No. 4, p. 409; Lake Placid Conf. Home Econ. Proc., 8 (1906), p. 64.

^c Jour. Amer. Med. Assoc., 48 (1907), No. 8, p. 655; Science, n. ser. 25 (1907), No. 639, p. 481.

A summary of data regarding dietary conditions in the United States published by the Department of Agriculture has been referred to elsewhere (see p. 386). The dietary standard suggested in this summary calls for 100 grams of protein and 3,500 calories of energy in the food eaten per man per day. Attention is especially directed in this report to the difference between dietary standards and physiological requirements, the former being simply guides for home and institution management.

STUDIES OF THE PHYSIOLOGY OF GROWTH.

Fundamental in their importance and in their relation to questions of nutrition are the extremely valuable series of investigations on the chemistry of growth reported from the laboratory of the Sheffield Scientific School of Yale University, by Mendel and his associates.^a The papers which have already appeared deal very largely with the enzymes of different tissues in embryonic life. The investigations have been summarized by Mendel^b and some general deductions have been drawn.

Many studies of growth have also been reported by Waters,^c then of the Missouri Experiment Station, and by S. H. Gage and Miss Susanna Gage, of Cornell University,^d while recent contributions to the subject have been discussed and data summarized by Pearl, of the Maine Experiment Station.^e

EXPERIMENTS WITH THE RESPIRATION CALORIMETER AND OTHER TECHNICAL STUDIES.

On the more technical side of nutrition work much has been accomplished. The report of experiments made by F. G. Benedict and R. D. Milner^f with their respiration calorimeter in 1903 and 1904, as part of nutrition investigations of this Office, was published about the beginning of the period included in this summary. Like the reports of previous investigations with the respiration calorimeter, this bulletin furnishes important data regarding the transformations of matter and energy in the body, the demands of the body for nutriment, the effects of muscular work upon such demands, and the actual nutritive value of different kinds of food materials and their ingredients. The results of eleven experiments, with five different men as subjects, are reported in which the balance of income

^a Amer. Jour. Physiol., 20 (1908), No. 1, pp. 81, 97, 117; 21 (1908), No. 1, pp. 64, 69, 77, 85, 95, 99.

^b Bio. Chem. Ztschr., 11 (1908), No. 4, p. 281.

^c Proc. Soc. Prom. Agr. Sci., 29 (1908), p. 71.

^d Science, n. ser., 28 (1908), No. 719, p. 494.

^e Amer. Nat., 43 (1909), No. 509, p. 302.

^f U. S. Dept. Agr., Office Expt. Stas. Bul. 175.

and outgo of matter and energy were determined. The experiments differ materially from earlier work reported in bulletins of the Office of Experiment Stations in that the respiration calorimeter with which they were made had been modified in important ways, so that the direct measurement of the oxygen consumed by the subject was possible. Preceding the account of the experiments is a description of the respiration calorimeter in its modified form, which it seems fair to say permits of a more complete determination of the balance of income and outgo of matter and energy in the human body than has hitherto been possible.

The improved form of the respiration calorimeter with special devices for the determination of oxygen was shortly thereafter described by Atwater and Benedict ^a in a bulletin of the Carnegie Institution of Washington. A later bulletin from the same source described an extensive series of experiments made by Benedict ^b with the apparatus on the metabolism of fasting men. The primary object of this report is to present an accurate statement of the results of an extended series of experiments with men on the effects of inanition, and detailed statistics are given of eighteen general metabolism experiments of one to seven days' duration and of two nitrogen metabolism experiments lasting, respectively, twenty-five and fourteen days. The measurements in most cases contained complete data as to the income and outgo of matter and energy measured with the respiration calorimeter and accessory appliances, together with observations of body weight, body temperature, pulse and respiration rate, strength tests, and blood examinations. The respiratory exchange and the heat output were subjects of special study. Experiments during prolonged fasting were included to note fluctuations from day to day and a series of two-day fasts with a number of men to eliminate the influence of individuality. In the longer experiments the subject was a young man who claimed some previous experience in fasting and in the remainder the subjects were university students.

The body excretions were the subject of special study. In the case of feces it was found practically impossible to isolate, with any degree of accuracy, material which could be properly designated "fasting feces." The urine was excreted regularly. The volumes were in general normal, though in many cases where the subject consumed large volumes of water the amounts excreted were likewise great. Considerable variation in the amount of total urinary nitrogen was noted, but even in the longer experiments the daily output seldom

^a A Respiration Calorimeter with Appliances for the Direct Determination of Oxygen: Carnegie Institution of Washington, 1905.

^b The Influence of Inanition on Metabolism: Carnegie Institution of Washington, Pub. 77; for a summary see N. Y. Med. Jour. and Phila. Med. Jour., 86 (1907), No. 12, p. 527.

fell below 10.5 grams. Detailed data are also given regarding the variations in excretion of other urinary constituents.

Marked variations in the amount of water vapor given off by the skin and lungs were observed in experiments with different subjects and smaller variations in experiments with the same subject. On an average, the results show that a fasting man gives off in this way not far from 600 to 800 grams of water per day.

As the fasting period progressed a rather persistent decrease in the carbon-dioxid output was noted. In the two-day fasting experiments wide variations in the carbon-dioxid output were observed with different subjects, though considering the period as a whole the agreement was reasonably uniform. Much wider differences were noted between the oxygen intake on the different days than was the case with the carbon-dioxid output.

The recorded data furnish information regarding the amounts of protein, fat, and glycogen katabolized in the body. The results show that the greatest draft on body glycogen occurred on the first day of fasting. After this a marked decrease in carbohydrate metabolism was noted, and on the second, third, and subsequent days not far from 20 grams of glycogen per day was lost on an average.

The average heat production in the fasting experiments was found to be not far from 2,000 calories per day on the first two days of the fasting period. When the experiments were continued longer the heat production diminished, and the author believes that 1,500 to 1,600 calories per day may be considered as approximately the minimum heat production of a man at rest without food. During sleep the heat production of such a man falls to 56 calories per hour, or at the rate of about 1,350 calories per day.

The recovery from fasting was rapid, and the author is of the opinion that there is a marked tendency on the part of the body to accumulate fat after short periods of fasting.

An interesting bulletin on the influence of muscular and mental work on metabolism and the efficiency of the human body as a machine by Benedict and Carpenter ^a has been published. Briefly, mental work was not found to exercise any appreciable effect on the factors of metabolism which were measured with the respiration calorimeter. As regards the effectiveness of the body as a machine, the authors calculate that it shows an efficiency of 20 per cent; that is, for every calorie of muscular work produced by the body a total of 5 calories is expended.

The reports of the Carnegie Institution for the last two years contain very interesting and valuable data regarding the installation and equipment of the Nutrition Research Laboratory, at Boston, and briefly report some of the work which has been accomplished. ^b

^a U. S. Dept. Agr., Office Expt. Stas. Bul. 208.

^b Carnegie Inst. Washington Year Book, 6 (1907), pp. 130, 200; 7 (1908), pp. 158, 209.

Benedict and Carpenter ^a have reported studies of metabolism during fever, studies of the energy involved in typewriting ^b and some other experiments, in all of which the respiration calorimeter was used. ^c Benedict ^d has also devised and described a small portable apparatus for use in respiration experiments.

Previous reports of this Office have briefly described the construction of the improved respiration calorimeter at the Department of Agriculture and outlined the plans for experiments with it.

This work is well under way and the special object of study is the ease of digestion of cheese of different sorts as compared with other foods. The scope and extent of the nutrition investigations of the Office of Experiment Stations has been outlined, the plans for the work discussed, and the publications listed and described in a recent circular. ^e

TEXT-BOOKS AND HANDBOOKS ON NUTRITION.

No report of the progress of food and nutrition investigations in the United States would be adequate without at least a mention of some of the numerous text-books and other volumes on these subjects which have appeared during the period under review, notably Lusk's Science of Nutrition, Bevier and Usher's Food and Nutrition, Hawk's Practical Physiological Chemistry, the valuable series included in the Library of Home Economics, Snyder's Human Foods and Their Nutritive Value, the new and enlarged edition by W. Gilman Thompson, of Practical Dietetics, Mohler and Eichhorn's translation of Edelman's Text-Book of Meat Hygiene, and others, too many to enumerate.

In the foregoing summary of work in human nutrition which has appeared in the United States during the last four or five years the attempt has been made to outline the principal agencies which contribute to the subject to give some idea of the general condition of nutrition investigations and to cite examples of investigations along the principal lines of work into which the subject naturally divides itself. It is recognized that the list is by no means complete, but it is believed that enough has been brought together to show that progress has been continuous and that important contributions have been made not only to the fund of available data of interest to students of nutrition and to practical workers, but also to the subject of methods of investigation and to the more important question of fundamental theories of nutrition.

^a Amer. Jour. Physiol., 24 (1909), No. 2, p. 203.

^b Jour. Biol. Chem., 6 (1909), No. 3, p. 271.

^c Amer. Jour. Physiol., 24 (1909), No. 2, p. 187.

^d Amer. Jour. Physiol., 24 (1909), No. 3, p. 345.

^e U. S. Dept. Agr., Office Expt. Stas. Circ. 89.



RECENT IRRIGATION LEGISLATION.

By R. P. TEELE, *Assistant Chief, Irrigation Investigations.*

During the summer of 1905 a study was made of the laws of the arid States relating to the use of water in irrigation, the results of which were published in a bulletin of this Office.^a Since that time there has been considerable legislation affecting irrigation, and it is the purpose of this article to discuss the legislation since 1905, with such references to previous legislation as are necessary to make plain the discussion of the later laws.

The legislation of the Western States relating to irrigation is of two classes, that which deals with the acquirement and protection of rights to water, or administrative law, and that which deals with promotion or organization of irrigation enterprises, which has for its purpose the promoting of irrigation development.

ADMINISTRATIVE LAW.

The greater part of the irrigation legislation of these States is of this class. In 1905 the States which had provided by law for fairly complete systems of public control of the acquirement of rights to water and of the diversion of water from streams were Colorado, Wyoming, Nebraska, Idaho, Utah, Nevada, North Dakota, and South Dakota. The most marked difference in the laws of these States are in the provisions for defining existing rights. These rights were acquired without public supervision, and while certain general principles as to the nature and limitations of water rights were generally recognized in all the States, there was no means of determining the application of these principles to any particular right until it had come into controversy and been passed upon by the court. The defining of such indefinite rights is a necessary preliminary to any orderly public control of diversions from streams since new rights are subordinate to these earlier rights, and no matter how accurately the new rights are defined as they are acquired they remain indefinite so long as prior rights are indefinite. Hence all the laws adopted both before and after 1905 attempt to bring about a speedy adjudication of existing rights.

The first step in this direction was taken by Colorado, which provided that when any suit involving the right to water was brought,

^a U. S. Dept. Agr., Office Expt. Stas. Bul. 168.

all parties claiming rights to water from the same source should be made parties to the suit, and established a special procedure for such suits. But this would not necessarily bring about a speedy adjudication because such a suit might not arise for years.

Wyoming made the next step, which was to provide for the collection of the information necessary for defining all rights to water by state officials, and the defining of the rights by an administrative board created by the state constitution for that purpose. This system differs from the other in two essential particulars—it takes adjudication of water rights out of the courts and it makes it unnecessary to wait until rights come into controversy before they can be defined. It changes the point of view entirely. Under the Colorado system the defining of rights to water from a public stream is considered purely a controversy between individuals, which must be adjudicated by a court, and which may be settled by agreement between these individuals, as many such cases were. Under the Wyoming system, on the other hand, the defining of rights is not considered a contest between individuals, or a judicial matter, but an action by the State to determine what rights have been established to the use of a part of a public property.

These two systems are the prototypes of those adopted by all the arid States and Territories, some following one and some the other. The advantages of the Wyoming system are generally admitted, but under the theory of the Colorado system that adjudications are controversies between individuals, they are held to be judicial matters which can not be taken from the courts. The States which have adopted the Wyoming systems are Nebraska, Nevada, and Oregon. New Mexico adopted this system in 1905, but abandoned it in 1907 for the Colorado system.

The States which have adopted the Colorado system have tried to secure the principal advantage of the Wyoming system—speedy adjudication, and the collection of data on which to base adjudications by public officials—but without great success. The state engineers or other officials were to bring actions for the adjudication of water rights after the engineers had made surveys and collected all the information necessary for such adjudications, making the process similar to that in Wyoming, except that the decree was entered by the court rather than by the board of control. This provision has been adopted in several States and Territories, notably Utah, Idaho, the Dakotas, Oklahoma, and New Mexico, but without much success. It was declared unconstitutional in Idaho (*Bear Lake v. Budge*, 75 Pac., 615), on the ground that the water commissioner who was to bring such action in Idaho was not a party in interest and could not bring such an action. The law is still in force in Utah, where the state engineer is to make surveys and collect information and

submit this to the court, which is to define rights, and in North Dakota, Oklahoma, New Mexico, and South Dakota, where the engineer is to make surveys and collect data, and submit the results to the attorney-general, who is to bring actions for adjudications.

The States of California, Montana, Washington, Kansas, and Texas, and the Territory of Arizona have not yet adopted laws under which they try to force adjudication or secure disinterested testimony on which to base decrees. With these exceptions all the States and Territories provide for the making of surveys and the collection of data on which to base adjudications by public officials, thus doing away with one of the worst evils of early adjudications, the basing of decrees defining rights on interested testimony alone, and often on stipulations between the parties to a suit, dividing up among themselves a public property to which they may or may not have acquired rights.

Since 1905 three new laws covering adjudications have been passed, each a different type, and, with the Wyoming law, presenting the four types which may be taken to represent present ideas on this subject.

The New Mexico law, adopted in 1907, provides that the territorial engineer shall make surveys and collect all available data, and file the results with the attorney-general of the Territory, who

shall, at the request of the territorial engineer, enter into suit on behalf of the Territory for the determining of all rights to the use of such water, in order that the amount of unappropriated water subject to disposition by the Territory under this act may become known.

The South Dakota law, adopted in 1907, provides that the state engineer shall make surveys,

obtaining and recording all available data for the determination, development, and adjudication of the water supply of the State, and upon the completion of the surveys shall file the results in his office, to be used as evidence in adjudications. Whenever a suit for adjudication is brought by any party a copy of the complaint must be mailed to the state engineer, and if in the judgment of the engineer the public interest requires action adverse to any part thereof, then he may call upon the attorney-general of the State to intervene in such action,

and the attorney-general shall do so. When a suit is brought on a stream for which surveys have not already been made, the court "shall by its order duly entered" direct the state engineer to make surveys and obtain data. In addition, the attorney-general is still to bring action when called upon by the State engineer to do so.

The Oregon law of 1909, the latest one passed, combines features of the Wyoming and Colorado systems in an interesting way. The adjudication is to be made by a board consisting of the state engineer and the superintendents of the two water divisions into which the

State is divided, but only on petition of one or more water users. The board makes its determination of the existing rights on the basis of surveys made by one of the superintendents and testimony collected by him, and files a copy in each county concerned, and within thirty days after this filing the order of the board and all the evidence on which it is based is filed with the clerk of the circuit court of the district. Any party interested may file exception to the order within thirty days after it is filed with the court. If no such exceptions are filed within this time the court is to enter a decree affirming the order of the board. If exceptions are filed the court is to hold hearings and may change the order of the board. Appeal may be taken to the supreme court of the State. Any person claiming a right to water from a stream under adjudication, who does not set up his claim, is barred from ever doing so.

Summarizing what has been said: Eight States and Territories—Wyoming, Nebraska, Utah, Nevada, North Dakota, Oklahoma, New Mexico, and South Dakota—have provisions for forcing adjudications. In three of these States—Wyoming, Nebraska, and Nevada—the adjudications are made by boards or officials, while in the others they are made by the courts in actions initiated by public officials. Three States—Idaho, South Dakota, and Oregon—provide for surveys and the collection of data by public officials for use in adjudications when these are initiated by parties claiming water rights. In Idaho and South Dakota these adjudications are made by the courts, and in Oregon by an administrative board. In the other seven arid and semiarid States adjudications are made by the courts on the testimony presented by the contending parties.

The Oregon law, referred to above, contains a provision relating to adjudications which is new. The superintendent, at the time of taking testimony, is to collect fees from claimants for recording certificates which vary with the quantity of water claimed. These fees are \$1 and 15 cents additional per acre up to 100 acres; 5 cents per acre above 100 acres and up to 1,000; and 1 cent per acre above 1,000 acres; for power rights, 25 cents for each theoretical horsepower up to 100; 15 cents above 100 and up to 1,000; 5 cents above 1,000 and up to 2,000, and 2 cents for each horsepower in excess of 2,000.

ACQUIREMENT OF RIGHTS.

The original method of acquiring a right to divert water from streams in the arid region was to post a notice at the point of intended diversion, stating the quantity claimed, and some other things, file a copy of this notice in the county records, build the necessary works, and put the water to a beneficial use. This was intended not as a limitation on the acquirement of rights, but as notice to subsequent appropriators of the existence of rights prior to their own. This

provision has been practically universal throughout the arid region. It had two great defects which made it a practical failure: (1) The actual diversion and use of water was necessary to the perfecting of a right, and this system provided no means of determining and recording whether the posting and filing of a notice was followed by construction of works and use of water. (2) The records of claims to a single stream might be scattered through a number of counties, making it difficult for anyone to determine what claims had been filed. The failure of this system necessitated the more or less elaborate provisions for adjudications just described. The present laws on this subject, where the old system has been abolished, have for their purpose the correction of the defects just mentioned—such supervision of the acquirement of rights as will define them as they are required, and the recording of all rights in one place.

In this field, as in that of adjudication, Wyoming was the pioneer, and the laws of the other States which have provided for supervision of the acquirement of rights follow the Wyoming law in its principal features. This law provides that any party wishing to acquire the right to divert water from any stream of the State must apply to the state engineer and secure a permit before beginning work, and provides for the submission of proof of having carried out the plans contained in the application and for the issuance of a certificate of right by the engineer. Up to 1907 similar laws had been adopted in Nebraska, Utah, Idaho, Nevada, North Dakota, South Dakota, and Oklahoma, while Colorado provided for the filing of plans with the state engineer and for their approval by the engineer, but had not provided for any proof of the plans having been carried out. Since 1905 laws similar to that of Wyoming have been adopted in New Mexico and Oregon, making ten of the seventeen States and Territories containing arid lands which have a complete supervision of the acquirement of rights.

Of the others, Montana (laws of 1907) has provided for supervision of the acquirement of rights from streams the rights to water from which have been adjudicated, but leaves rights from unadjudicated streams to be acquired by posting and filing notices and construction of works and use of water. Any party wishing to appropriate water from an adjudicated stream is to post and file a notice giving the volume of water to be taken, the purpose for which it is to be used, the place of use, the name of the stream, the name of the appropriator, and the date. No rights can be acquired in excess of the carrying capacity of the works built or the needs for some useful or beneficial purpose. Within forty days after the works are completed the owner must file with the clerk of the district court in the county where the appropriation is to be made an application to have the ditch measured and its capacity determined. This application is to contain a sworn

statement showing the name of the stream, the volume of water to be diverted, the point of diversion, the proposed use and the place of use, and the name of the appropriator. On receipt of this application the clerk is to record it and employ some competent civil engineer to measure the ditch and locate the exact point of diversion and report these within thirty days with a plat on which shall be shown the point of diversion, the date of the notice of appropriation, the date of the survey, the name of the stream, the name of the appropriator, the purpose and place of intended use, and if for irrigation, the location and area of land to be irrigated. On receipt of this report, the clerk is to publish notice once a week for three weeks in some newspaper, giving the facts. Any party interested may file objections. After publication, the clerk is to file the report and all objections raised, and on the first day of the next session of the court present them to the court. If no objections have been filed, the court shall enter an order allowing the appropriation. If objections are filed, the court is to fix a date for a hearing, and, after the hearing, the court is to make whatever order seems proper. Under this law, when a stream has once been adjudicated, rights to water from it will be defined as acquired, maintaining the list of rights complete.

The principal point of difference in the laws requiring the securing of permits from the state engineers is in the degree of discretion allowed the engineer in approving applications. The state engineer of Wyoming is required to reject an application "where there is no unappropriated water in the proposed source of supply, or where the proposed use conflicts with existing rights, or threatens to prove detrimental to the public interests." Some of the other States have followed this, while others allow the engineer to reject applications where there is no unappropriated water or the proposed use would conflict with existing rights, while others—notably Idaho—provide that "it shall be the duty of the state engineer to approve all applications made in proper form which contemplate the application of the water to beneficial use." (Laws of 1903, p. 226.)

Utah included the Wyoming provision in its law of 1903 but amended it in 1905, taking away from the engineer the power to reject applications because of hostility to the public interests. Of the new laws enacted since 1905 all provide for the rejection of applications the approval of which would be detrimental to the public interests. New Mexico and South Dakota place this power in the engineer, while in Oregon the engineer is to report such cases to the board of control, which is to decide therein. The only instance coming to the writer's notice in which an application was refused by a state engineer on the ground of conflict with the public interests was in Utah. That case was appealed to the court, where the engineer was overruled and this power denied to him, although the law

granted it specifically. The case was not taken to the state supreme court and the law was repealed. This Utah case was interesting because the right applied for contemplated an entirely proper use of the water, but a use which, in the opinion of the engineer, was not the best use which might be made of the water in question. In the other States this issue has not been raised, the engineers not considering it wise to reject an application for a present use in favor of a possible better use in the future, although this would seem to be the field for which such a law is especially adapted.

The Idaho law above referred to, requiring the engineer to approve any application which is in proper form, has been criticised because under it the engineer is compelled to approve plans for schemes which he may know to be fraudulent, because there is no unappropriated water in the source of supply filed on, thus enabling the promoters to go before the public selling rights on the basis of an approved application, the approval of which signifies only that the application is in proper form. To remedy this a law was passed in 1909 requiring parties proposing to sell rights to file plans and proposed contracts with the state engineer and state land board and petition the board for the right to sell rights. The engineer is to examine the plans, determine the capacity of the works, the sufficiency of the water supply and the duty of water, and report to the land board, after which the board is to issue a certificate showing the number of rights which may be sold, the number of acres which can be irrigated, and the form of contract which shall be used. This certificate is to be recorded in the office of the county recorder. All contracts for rights are to be of the form specified, and are to be recorded in the office of the county recorder as soon as sold. Any contract or deed issued before the recording of the certificate or in excess of the amount authorized is null and void, and the seller is liable to the purchaser for damages and to a fine of \$100 to \$300 or to imprisonment not exceeding six months. This law does not apply to Carey Act or reclamation projects, since Carey Act projects are approved by the engineer and land board under other laws. This law is very much needed in Idaho as well as in other States, because of the fact that purchasers of water rights are more at the mercy of promoters than the purchasers of almost any other form of property, since water rights are difficult to understand and there is no way in which the uninitiated can determine the value of the rights of the company selling rights. While the examination by the state engineer and the issuing of a certificate by the state land board does not guarantee the value of the rights, it is good evidence of their value.

The general irrigation laws of Utah were amended in several details. One important change was made in the fees to be collected by the state engineer for examining and filing papers. The old law provided

a flat rate for all applications (1905, ch. 108), and under the decision of the Utah courts the engineer has no authority to reject applications. There was, therefore, no limitations on the quantity of water which might be filed on by an applicant for permit to appropriate water. This was changed in 1907 (ch. 156) by making the filing fee depend upon the quantity of water applied for, the fee being \$2.50 for any quantity up to 10 cubic feet per second, and \$1 for each cubic foot per second above 10. One dollar per cubic foot per second is not a burdensome fee for a legitimate enterprise, but it will be a check upon extravagant claims, such as were sometimes filed under the old law.

While the laws of the States mentioned provide a procedure for acquiring rights, they do not all provide penalties for diverting water without following this procedure. In 1907 Wyoming and South Dakota enacted laws making diversion before securing a permit a misdemeanor.

DISTRIBUTION OF WATER.

New Mexico and Oregon included in their laws enacted in 1907 and 1909, respectively, the provisions common to most of the arid States, for the division of their territory into districts and the appointment of commissioners within those districts charged with the distribution of water from streams to the canals entitled to receive it.

In New Mexico the territorial engineer is to make these appointments, either on the application of a majority of the water users of the districts or on his own motion. These commissioners are to receive \$4 per day for the time actually employed. Ditch owners are required to put in head gates and measuring devices, and in case of refusal the engineer may refuse to deliver water to them. No commissioners are to be appointed until streams are adjudicated.

The Oregon law of 1909 provides that the board of control shall divide the State into districts and appoint water masters, who are to distribute water. They are to receive \$4 per day for the time actually employed, or \$100 per month, to be paid by the counties in which the work is done. Under the law—

said water master shall as near as may be regulate and control the use of the water of all streams within his district by such closing or partial closing of head gates as will prevent the waste of water, or its use in excess of the volume to which the owner of the rights is lawfully entitled.

The provision quoted is different from the laws of the other States, which direct the commissioners to distribute the water in accordance with the decreed or other defined rights. It is not likely that this will make the administration of the Oregon law different from that of any of the others.

Some of the States having older laws covering the distribution of water have amended these recently. A law adopted in 1909 in Idaho provides for the division of the State into districts on drainage lines, and for an election in each of these districts on the first Monday in March of each year, at which the holders of adjudicated rights to water are to elect water masters and fix their pay, not to exceed \$4 per day. If water masters are not elected the water commissioners may appoint them. Water masters are to distribute water in accordance with adjudicated rights, and unadjudicated rights are to be considered subsequent to all adjudicated rights. Water masters are not to begin work until called upon by two or more persons having rights to water. The owner of stored water may use the public streams to deliver this water. He shall notify the state engineer of the date and amount of water to be run, and the parties to whom it is to be delivered. The engineer is to appoint one or more deputies to attend to this delivery, and set the head gates of all ditches so as to allow the water to go to the parties entitled to it. Anyone changing a head gate fixed by such deputy is guilty of a misdemeanor and is liable to a fine of not less than \$50 nor more than \$250, or imprisonment for thirty days to six months. Washington, in 1907, adopted a similar provision, except that in that State, in which there is no state engineer, notice of the intention to run stored water in a stream is to be sent to the superior court of the county in which water is "stored, carried, or used," and the court is to appoint a commissioner to attend to delivery, to be paid not exceeding \$7 per day, by the county in which the work is done.

In 1907 Wyoming amended its law and gave water commissioners authority to regulate the distribution of water from partnership ditches for which rights have been adjudicated. Whenever a head gate or controlling work has been set by a water commissioner he is to put a notice of that fact on the gate. Ditch owners are required to put in head gates and measuring devices under penalty of having the water shut off. Reservoir owners are to put in measuring devices above and below reservoirs, and in case of refusal the water commissioner is to open the outlet of the reservoir and leave it open until the devices are put in.

TRANSFERS.

Until the last few years the prevailing rule regarding water rights in the arid States has been that rights might be transferred from one tract of land to another if holders of other rights were not injured by the transfers.^a Until the rendering of the decision just cited the

^a See *Johnston v. Little Horse Creek Irrigation Company* (Wyo.), 79 Pac., 22, in which the supreme court of Wyoming cites the authorities on this subject.

Wyoming board of control had held that rights could not be transferred from the lands in connection with which they were acquired, and in 1909 this was enacted into law in that State. Since 1895 rights in Nebraska have been inseparably attached to definite tracts of land. With these two exceptions water rights may still be transferred, but in the years from 1903 to 1909 there has been much legislation on this subject, the general purpose of which has been to bring such transfers under the control of the state officials charged with the supervision of the use of public water supplies. Prior to 1903 the general practice was for parties wishing to do so to make transfers, putting on those considering themselves injured the burden of bringing actions to prevent the transfers. The laws enacted since that time require the party wishing to make a transfer to secure permission in some form before making it, thus giving parties who might be injured notice and an opportunity to protest. In all of the States and Territories which have enacted laws prescribing the procedure for making transfers, except Colorado, they must be referred to the state engineer. In Colorado application is made to the court which issued the original decree covering the right to be transferred, and the proceedings are the same as for an original adjudication (Laws 1903, p. 278; 1905, p. 244), and include notice to parties interested, a hearing before the court, and the issuing of a decree either allowing or disallowing the transfer. In the other States application must be made to the state engineer, notice of the proposed transfer must be published, a hearing is held, and the transfer allowed or disallowed by the engineer, with appeal to the courts.

The argument in favor of transfers is that they are essential to the economical use of water. If rights may be transferred the tendency will be for the water to gravitate to the land where it will bring the largest return, while if they are inseparably attached to particular tracts of land the holders of rights will continue to use water on inferior lands rather than forfeit their rights by discontinuing the use of water.

Over against this economic advantage has been set the fear that if a water right may be transferred apart from the land on which the water is used, it will become the subject of separate ownership, and, since arid land is almost valueless without water, the landowner will be at the mercy of the water owner. American experience thus far has not shown this danger to be a real one, but the laws regarding transfers passed in recent years, guard against it by providing that ^a the right may only be transferred to and immediately become appurtenant to other land. In other words, a water right can not be held

^a "If for any reason it should at any time become impracticable to beneficially or economically use water for the irrigation of any land to which the right of use of the same is appurtenant, said right may be severed from said land and simultaneously transferred and become appurtenant to other land." (North Dak. Laws 1905, sec. 50.)

independently of some definitely described tract of land. This provision would seem to guard effectively against any exploitation of the landowner by the water owner, since they can not be separate.

However, the strongest objection to transfers of water rights in the State of Wyoming, which is the only State recently enacting legislation against them, is administrative rather than economic. The laws of that State and of most of the other arid States provide for the adjudication of existing water rights and for the acquirement of new rights in such a way that there will eventually be a complete list of rights to water in each State, which will serve as a basis for distributing water from streams. It is contended that if rights can be transferred without formalities these records of rights become valueless immediately, since they may or may not represent the status of rights at any time. It will be observed that this is not an argument against transfers in themselves, but against unrecorded transfers. If the transfers must be recorded in the same place where the records of rights are kept, the records will remain complete. This has been provided for in the laws on this subject.

An important point of difference in the laws relating to transfers is in the provisions covering the transfer of rights in their entirety or in part. A group of States—North Dakota, Oklahoma, Utah, Nevada, and Oregon—require the total severance of the right from the original tract of land and its immediate transfer to another tract (see footnote p. 408). Idaho, South Dakota, and New Mexico, on the other hand, allow a transfer of a part of a right. The Idaho law allows the water-right holder to "voluntarily abandon the use of water in whole or in part on the land which is receiving the benefit of the same, and transfer the same to other land." (Laws 1903, p. 234; 1905, p. 28; 1907, p. 508.) The New Mexico law of 1907 (sec. 44) provides that—

by and with the consent of the owner of the land, all or any part of said right may be severed from said land and simultaneously transferred and become appurtenant to other land, or may be transferred for other purposes, without losing priority of right theretofore established.

The two laws just quoted are not altogether clear as to whether the holder of a right might continue to irrigate the entire area for which he had a water right, and, by using less than the volume of water decreed to him, secure a surplus which may be transferred to other lands. The South Dakota law, however, seems to be clear on this point. The South Dakota law of 1905 provided that the transfer might be made if it became impracticable to "use water" on the land, while the 1907 law provides that—

if for any reason it shall at any time become impracticable to use *all or any part of said water* beneficially or economically for the irrigation of any land to which the right of use of the same is appurtenant, *all or any part of said right* may be severed from said land and simultaneously transferred to other land.

Under the new law, if the water user can by economy and care mature his crops on the land in connection with which the right was acquired, with one-half the water allotted to him, he may transfer the water saved to other land, in that way benefiting himself and at the same time benefiting the public, since the water supply, which is limited, will have been made to serve double the area which would otherwise have been served. Under the old law, on the other hand, there is no incentive to economical use, since the use of water on the old land must be abandoned, and the right transferred entire to an equal area of new land. The procedure for securing a permit to transfer a right was not changed. Although Wyoming has prohibited transfers of rights it does not insist on an absolute enforcement of that restriction. Along with its law of 1909 prohibiting transfers it enacted a law allowing rotation in use, which is as follows:

To bring about a more economical use of the available water supply it shall be lawful for water users owning lands to which are attached water rights to rotate in the use of the supply to which they may be collectively entitled; or a single water user, having lands to which water rights of a different priority attach, may in like manner rotate in use, when such rotation can be made without injury to lands enjoying an earlier priority. (Act Feb. 27, 1909.)

IRRIGATION DISTRICTS.

Colorado amended its irrigation district law in a number of details, the only change of general interest being one relating to the qualifications of electors of a district. Under the law of 1905 (ch. 13) nonresident property owners were entirely excluded from voting on district affairs, while under the law of 1907 (ch. 194) the franchise is extended to parties who

are the owners of lands to the extent of 40 acres or more within said district and reside within any county into which any part of said district shall extend, and who are qualified electors under the general laws of the State therein, and who shall have paid property taxes upon property located within said district during the year previous to any such election.

Idaho revised its irrigation district law in 1907 (ch., 140), but no important changes were made in the general plan of the law, except that entrymen on public or state lands are made eligible to sign petitions for the formation of districts and to vote on their organization.

Montana adopted a new irrigation district law in 1907 (ch., 70). The distinctive features of this law, when compared with others, is the fact that the nonresident property owner is given as much voice in district affairs as the resident. In some States one of the principal reasons for the creation of irrigation districts is to compel the non-resident to improve his property, or at least contribute to the cost of

building irrigation works which will make his property valuable. The Montana law gives the nonresident full protection as follows:

Any taxpayer holding title or evidence of title, or any duly authorized and qualified guardian, executor, or administrator of an estate, or the duly authorized agent of any corporation or company owning land within any irrigation district, shall be deemed qualified to sign any document or petition, or to vote at any election authorized under this act, if not otherwise disqualified under the laws or constitution of the State.

The petition for the organization of an irrigation district must be signed by a "majority in number of the holders of titles, or evidence of title," and must represent "a majority in acreage of said lands." In all elections and votes on bond issues "each elector shall be permitted to cast one vote for each 40 acres of irrigable land or major fraction thereof owned by such elector in the division where his ballot is cast, but any elector owning less than 20 acres shall be entitled to cast one vote." The organization of a district requires a two-thirds favorable vote, while the issue of bonds requires a majority vote. The bonds and annual charges are apportioned on the lands

according to the value of such tract for irrigation, irrespective of improvements, and such valuation for irrigation shall be fixed according to the increased value of such tract by reason of such irrigation as compared with other irrigated lands in the district.

Wyoming also adopted an irrigation district law in 1907 (ch., 72). This law is along the general lines of the district laws of the other States. Like the Montana law, it allows nonresident property owners to vote on district matters, the provisions covering that matter being as follows:

At said election and all elections held under the provisions of this act, all persons who are both freeholders and also qualified electors within said proposed district and who have paid a property tax in said proposed district during the year next preceding such election shall be entitled to vote, and none others.

"Qualified electors" are defined as follows:

For the purpose of this act the words "qualified elector or electors" shall be understood to be a citizen of the United States, or who may have declared his or her intention to become such, and that any person so qualified shall have power to do and perform any and all things requisite and necessary for the purpose of this act, the same as if he or she were a bona fide resident of said district.

The petition for the creation of a district must be signed by a majority of the freeholders owning land in the proposed district, who must also be owners of a majority of the whole number of acres of land. A majority vote will carry the organization of the district and bond issues. Bonds may not be sold for less than 95 per cent of their face value, but if no satisfactory bids are received for bonds they may be issued in payment for works. For payment of bonds and interest the lands are taxed at a flat rate per acre, but the cost of maintenance

and operation may be met by charging tolls for water used, by assessments on the land, or both. The county treasurer is *ex-officio* treasurer of districts.

The provision in the Montana and Wyoming laws for the representation of nonresident property owners is an advance over other laws, as it has been stated often that the district law is designed especially to exploit the nonresident. This has led to attacks upon the legality of the organization of districts and to opposition at every possible point by property owners who were opposed to the organization of districts which included their property, and in the past this has done much to detract from the salability of district bonds. The allowing of votes to nonresident property owners may make it more difficult to secure the organization of districts, but it will make the sale of their bonds when organized much easier.

In all of the States the limitation on the price at which bonds may be sold is a dead letter, because of the fact that they may be issued in payment for works. It is customary to arrange with some contractor for the building of the proposed works or for the purchase of works already built on the basis of payment in bonds, and the price is fixed accordingly. A recent newspaper report states that the bonds of a certain district in a State where bonds may not be sold below 95 were taken by the contractor at 37 cents. In other words, the people of that district are paying nearly three prices for their work.

GENERAL LEGISLATION.

The water laws of many of the arid States contain statements of principles and definitions which show the attitude of the legislators, although they may not affect the administration of the laws. Most of them have declarations as to the ownership of the waters of the streams and other sources of water supply, some declaring that such waters are the property of the State and some that it belongs to the public, the difference in theory being that if the water belongs to the State it can administer it as proprietor, while if it belongs to the public the State administers it as sovereign, under its police powers. This seems to be largely an academic question, and the new laws passed since 1905 in New Mexico and South Dakota declare water to belong to the public, while Nevada repealed a similar declaration and in 1907 declared it to be the property of the State. The Oregon law adopted in 1909 makes no declaration on this point, providing that "subject to existing rights, all waters within the State may be appropriated for beneficial use."

Wyoming in 1909 incorporated in its laws a definition of a water right which is interesting. It is as follows:

A water right is a right to use the water of the State, when such right has been acquired by beneficial application of water under the laws of the State relating thereto,

and in conformity with the rules and regulations dependent thereon. Beneficial use shall be the basis, the measure, and the limit of right to use water at all times, not exceeding in any case the statutory limit of volume.

This is followed by a clause giving the relation of rights to water for different uses, as follows:

Preferred users.—Water may be condemned for preferred uses, as follows: First: Drinking by man or beast. Second: Water for municipal purposes. Third: Water for steam engines and for general railway use. Fourth: Water for culinary, laundry, bathing, refrigerating (including manufacture of ice), and for steam and hot-water heating plants. The use of water for irrigation shall be superior and preferred to any use where turbine or impulse water wheels are installed for power purposes.

The procedure embraces a public notice, an inspection and hearing if necessary, and an order by the board of control.

Oregon is one of the few States containing arid lands in which riparian rights are recognized, and for many years this has stood in the way of the adoption of laws providing for the diversion and use of water on nonriparian lands. The 1909 law recognizes riparian rights made use of in the past but abrogates them for the future, the clause covering that point being as follows (Laws 1909, ch. 216, sec. 70):

Nothing in this act shall impair any vested right. Use of water by riparian owners prior to this act confers a right to the extent of use. If riparian owner has in good faith begun works at time of this act, the right to take and use such water is deemed vested, but board of control may fix date for completion.

The people of Colorado seem to be apprehensive of the encroachments of the Federal Government on the State's control of both lands and waters within the State, and in 1909 the legislature authorized the attorney-general to—

investigate acts of the Federal Government in regard to public lands in the State of Colorado, and in regard to the waters of the State; and to institute such suits as he may deem necessary in the name of the State to determine whether or not the Federal Government is encroaching upon or usurping the rights and powers of the State to the detriment of the interests of the people, or in any way in Colorado violating the laws or the Constitution of the United States.

Twenty thousand dollars was appropriated to cover the expenses incurred.

Rapid development along irrigation lines has taken place in Texas during the last few years, and the State has no adequate system of laws for controlling or supervising this development. To meet this condition the legislature in 1909 authorized the commissioner of agriculture to investigate and report upon the present system of irrigation within the State, including—

The cost of maintenance and operation of the same, the character and kind of irrigation plants which result in the greater saving to the users of water, the class and character of water contracts entered into by the various canal companies; he shall also inquire into the reasonableness and fairness of rates being charged for water by the various canal companies in the State, and from time to time shall make public the result of

the inquiries; he shall collect and publish statistics and other information regarding the irrigation of rice and other crops as may be of benefit in developing and collecting a more efficient system of laws, safeguarding and defining the rights of users and sellers of water for irrigation purposes; and he shall make up and file an annual report on the same with such recommendations as he may deem beneficial to the industry, which report shall be filed with the governor and transmitted to the legislature, and he is to employ an engineer and expert.

Taken as a whole, the legislation in the years since 1905 has marked quite an advance in the adequate public control of the diversion of water from public streams. New Mexico and Oregon have adopted codes in general similar to those of the other States. Montana has provided for maintaining complete lists of rights on streams already adjudicated, while most of the States have amended their laws to strengthen the weak places which have developed.

The amendments to irrigation district laws have been in the direction of equity in allowing a voice to nonresident property owners, which must prove of advantage in lessening attacks upon the validity of the organization of districts.

That there is a considerable interest in the adoption of adequate laws in the States which have not such laws at present is evidenced by the provision for investigations in Texas, by the appointment of a commission to draft laws by the governor of the State of Washington, and the agitation for similar action in some of the other States.

RECLAMATION OF THE SOUTHERN LOUISIANA WET PRAIRIE LANDS.

By A. D. MOREHOUSE,^a *Office Engineer, Drainage Investigations.*

INTRODUCTION.

In the conquest of the country the heavily timbered areas of the East have been subdued, the vast prairie lands of the Middle West have been settled, the riches of the west coast have yielded of their stores, the waterless regions of the Great American Desert have broken into verdure under the magic of irrigation, and "dry farming" has brought into productiveness immense sections of land once considered worthless. However, throughout the space of the several centuries which have witnessed this wonderful development, one of the richest sections of the country's great domain has lain unused and unproductive; first, clothed in the mystery cast upon it by its Spanish ownership, and later, since its acquisition by the United States, associated in the minds of men with visions of pestilential swamps, deemed worthy only of neglect owing to the supposed difficulties of its reclamation, and never thought to be a region whose wonderful agricultural possibilities would test the credulity of men.

Within the last few years all this has changed and the alluvial prairie lands of southern Louisiana are coming into their own. Formed by the richest soils of the whole Mississippi Valley, brought down for centuries by that river and its tributaries and deposited here by every recurring flood, they form now "the most fertile agricultural lands of the State, equaled by few and surpassed by none in the world in productive capacity," as described by Doctor Hilgard in writing of this region.

FORMATION OF THE LANDS.

Recent borings to a depth of 3,170 feet in the vicinity of Houma have failed to penetrate this layer of sediment, and at a depth of 2,400 feet pieces of fairly preserved wood have been encountered. Owing

^a This article is based on reports to the chief of drainage investigations, by A. M. Shaw, C. E., New Orleans, La., and Prof. W. B. Gregory, M. E., Tulane University, of their investigations made during 1909, and also upon data furnished by C. W. Okey, assistant drainage engineer, who is continuing the work of this Office during 1910 in southern Louisiana. All quotations not otherwise credited are from the above-mentioned reports, the portions referring to pumping equipment being by Professor Gregory and the rest by Mr. Shaw.

to the fact that the soil is water-laid material, nothing coarser than river sand is encountered except the overlying layer of humus formed by the decaying vegetation. A typical section of these lands would show a layer of humus or muck 2 or 3 feet thick overlying a grayish or drab clay subsoil composed of very fine particles, which when saturated form a tough, impervious mass. Layers of sand of varying thickness are encountered in this clay subsoil, and occasionally no clay stratum intervenes between the humus and sand. The surface soil is from a few inches to 5 feet or more in thickness.^a

NATURAL LEVEES.

The embankments or natural levees along all the bayous and streams with which this region abounds, and those along the Mississippi, are formed by the constant overflows. They are composed of coarser sand than the clay subsoil of the prairies, as this latter was deposited in the more slowly moving waters away from the main currents of the streams. This point, as well as the fact that the natural drainage is away from the river, is well brought out by the following from A Preliminary Report upon the Bluff and Mississippi Alluvial Lands of Louisiana, by W. W. Clendenin,^b written a few years since:

With every flood the river now overflows its flood plain and deposits much of the sediment from its headwaters. As with a slight increase in velocity the transporting power is vastly increased, so with a slight checking of velocity, as occurs over the flood plain outside of the channel, deposit takes place. As the greatest decrease in velocity takes place near the channel, there the heaviest and coarsest sediment is deposited, and in greatest quantity. The river banks are thus built higher by each flood and a system of natural levees is produced. There is thus a marked difference in the "front lands" and the "back lands" along the river. The former are higher and coarser textured than the latter, and therefore much more easily cultivated and drained.

Drainage from the very channel margin is away from the river, and, unless forced by the topography of the land, will not reach the river proper, but unite with some outlet of the river produced during some extraordinary flood period and kept open by the escape of water during ordinary periodic flood stages. As the feeders of the river are called tributaries, these outlets have not inaptly been styled distributaries.

The water in breaking over the banks and spreading over the marshes in sheets was gradually lessened in velocity, thus gradually dropping its load of sand and silt and causing a delicate gradation of soil texture to the finest river silt far out in the marshes. These natural levees and those that have been constructed, and the improved methods of closing crevasses in the levees, have reduced the danger from general overflows to a minimum; and whereas this has prevented much damage which would be caused by the cutting out of new channels and the destruction of much valuable property, it has also checked the building up of the lowlands and their natural

^a For a discussion of these soils, see U. S. Dept. Agr., Field Operations of the Bureau of Soils, 1903, p. 439.

^b Louisiana Stas. Rpt. Geology and Agriculture, Pt. IV, p. 263.

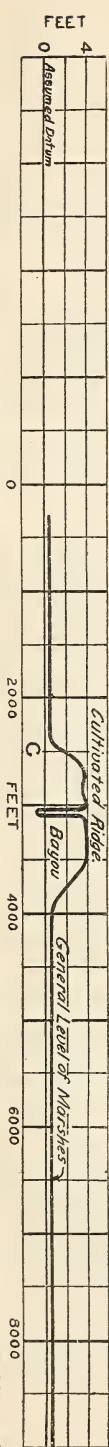
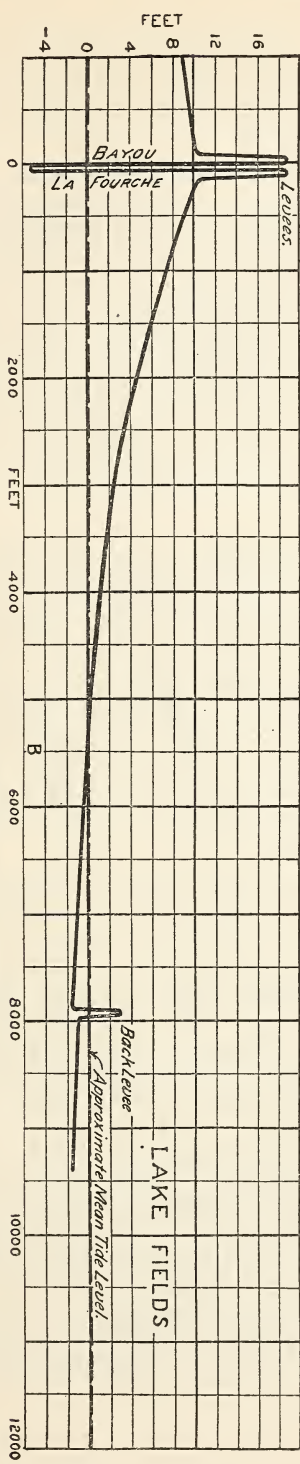
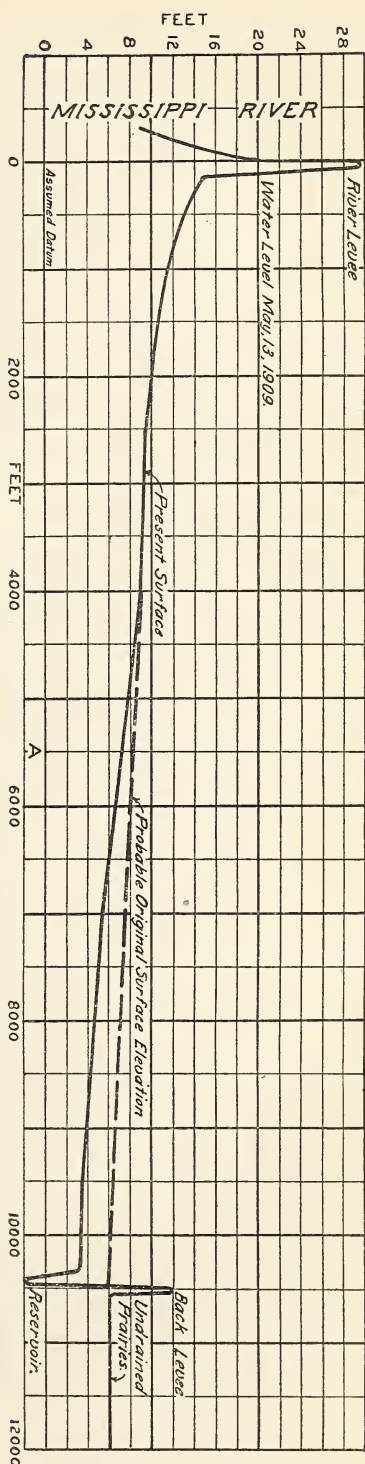


Fig. 1.—Typical examples of Louisiana marsh land formation: A, profile through Willwood plantation; B, section through Smithport plantation; C, formation caused by small bayou near Lockport.

conversion from marshes to well-drained fields. Thus it is that nature has forced upon man the necessity of exercising his ingenuity and labor in wresting these productive lands from their water-ridden state, even as centuries ago the brave and industrious Hollanders wrested their empire from the sea.

Many of the streams and bayous now isolated have served in times past as mouths of the Mississippi or as overflow outlets in times of flood, and they have been instrumental in the distribution of the rich silt-laden waters and in the gradual advance of the coast line.

Even before the construction of the artificial levee system, there was no raising of the general level of the marshes during periods of normal flow and probably little sedimentation of the river bed excepting at its mouth, the most of the material which was carried in suspension to the lower portion of the river being carried out and deposited in the Gulf. As the river rose, however, the waters constantly sought additional outlets through the various bayous of the delta country. At times of extreme high water there was a general breaking over the banks of the river and its outlets. It is probable that the most of the building up of the lands above sea level has been done at such times.

The fact of the silt-bearing capacity of water being directly dependent upon the velocity is clearly demonstrated by observing the natural embankments formed by streams of various sizes. In the case of smaller streams when the water overflows, its force is soon spent and the silt is quickly deposited near the stream, forming narrow ridges with steep side slopes, while those formed by large streams are broad with slight slopes. Three typical examples, showing this difference and the manner in which the land surface has been raised on the marshes, are given in figure 1, A, B, and C.

The sections were taken as follows:

A—From the right bank of the Mississippi River across the Willswood plantation, about 10 miles above New Orleans. This section is about 2 miles long and a part of the lands crossed have been under cultivation for a great many years, while those farthest from the river were reclaimed only twelve or fifteen years ago. The lowering of the surface of the cultivated and drained fields due to the shrinkage of humus soils is here well illustrated. There are many examples of highlands having been built up for much greater distances from the river than this, but as such accretions are indirect, on account of being formed by a number of small bayous or temporarily contracted areas of overflow which assisted in maintaining the velocity, these have not been considered as being typical.

B—The right bank of Bayou La Fourche at Lockport, extending back through the village of Lockport and the lands of the Smithport Planting Company to Lake Fields. Until 1903, Bayou La Fourche served as an overflow outlet for the Mississippi River, the opening at Donaldsonville not having been permanently closed until that year.

C—This is a very small bayou running through the lands of Dr. I. D. Fay, about 4 miles west of Lockport. The abrupt rise of the ridge from the surrounding marshes is especially noticeable and is characteristic of smaller bayous.

Important exceptions to the foregoing general statement as to the relation between the size of bayous and the ridges built by them are frequently found. Prominent

among those are the Bayou L'Ourse, in the southeastern part of La Fourche Parish, and the Wax and Little Wax bayous, in St. Mary Parish. Bayou L'Ourse is an insignificant stream, occupying the center of a long and important ridge. It is probable that at one time this bayou served as an outlet for the La Fourche or possibly of some predecessor of the latter bayou, draining in a more easterly direction through Bayou Blue, Lake Fields, and Long Lake. Wax and Little Wax bayous are streams of erosion rather than of sedimentation and have been formed wholly or in part by the action of storms and the tidal flow which is quite strong along this portion of the coast. As a result, the bayous are bordered by the marsh or by very low ridges. Both streams are from 10 to 50 feet in depth and 100 to 200 feet in width.

From the foregoing discussion it is seen that these lands may not in general be drained through gravity outlets in the ordinary way, but that it is necessary to surround them by levees or embankments and then, by the construction of an interior drainage system of ditches, lead the drainage water to some convenient point from which it is pumped over the embankment into the adjacent stream or bayou.

PURPOSE OF INVESTIGATIONS.

The development of these lands is now progressing with such rapidity that the United States Department of Agriculture, through Drainage Investigations of the Office of Experiment Stations, decided in the spring of 1909 to make a study of the various conditions entering into the reclamation of these most valuable lands.

The engineers making the investigation were charged to determine the volume of water, or percentage of the rainfall, which it is necessary to pump from the fields in order to secure adequate drainage of these soils; the area of the field surface occupied by ditches, and the depth, width, and arrangement of the ditches and the levees required in a drainage system; the influence of bad physical condition of ditches upon the efficiency of the system; the distance from the ground surface at which the water table should be maintained; the difference in the level of the water in the ditches while the pumps were in operation; the percentage of saturation or the quantity of water which the soil should contain when in the best condition for growing crops.

Accordingly, four reclaimed tracts of land were chosen in the vicinity of New Orleans, which were regarded as having good ditch systems, coupled with ample pumping capacities, and, as practically no information was extant as to the relation of rainfall to the resulting run-off from these lands, rain gauges were established on each tract and continuous rainfall records kept, in order to compare them with the pumping records for the same period.

The following gives a brief description of the tracts in question, including their pumping machinery equipment, and also describes a new tract, District No. 3, which is being reclaimed in the spring of 1910.

DESCRIPTION OF EXPERIMENTAL TRACTS.

WILLSWOOD PLANTATION—2,400 ACRES.

The plantation as shown by figure 2 fronts on the Mississippi about 10 miles above New Orleans and is crossed by the Southern Pacific Railway. The tract was enlarged twelve years ago, necessitating the digging of new canals and the replacing of the old wheel pump by an up-to-date pumping plant. Sugar cane is grown principally, but

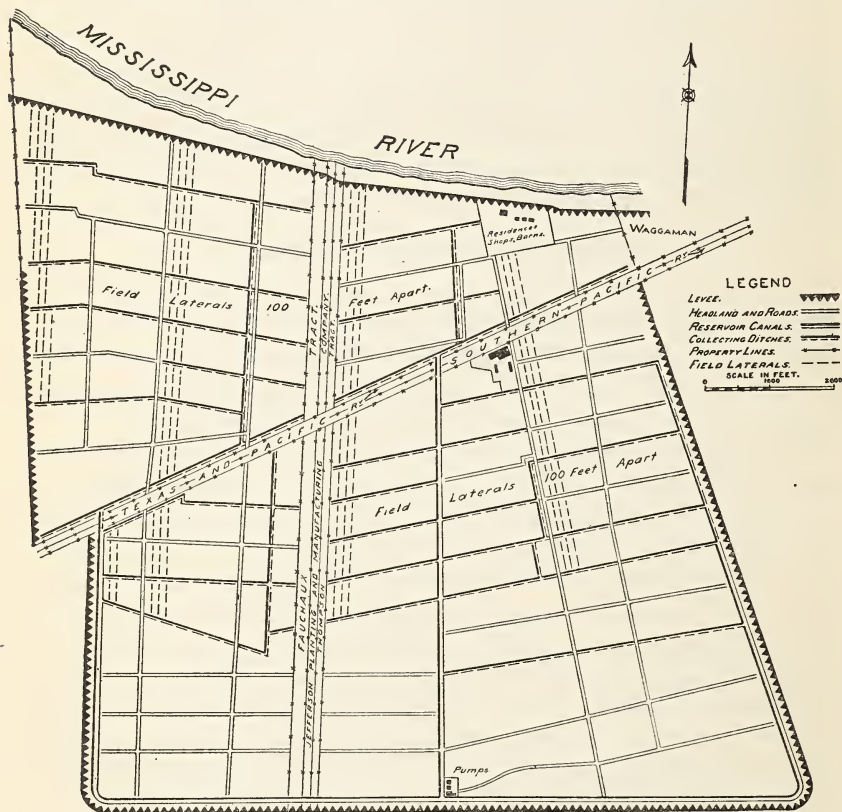


FIG. 2.—Map of Willswood plantation, Waggaman, St. Charles Parish, La., showing ditch and levee system.

some corn and cowpeas are also raised, cultivation having taken place for a number of years.

Steam for the three following pumping units is furnished by two water-tube boilers and one return tubular boiler, crude oil for fuel and a feed water heater being used.

(1) One 40,000 gallons per minute maximum capacity rotary chamber-wheel pump, rope driven from a 16 by 24 automatic, non-condensing engine.

(2) One 42-inch by 16-inch Menge pump, connected by a rope drive and a bevel gear to a 16 by 24 automatic, noncondensing engine.



FIG. 1.—WILLSWOOD PLANTATION, ST. CHARLES PARISH, LA., SHOWING PUMPING PLANT AND MAIN RESERVOIR, WITH LEVEE ON RIGHT BANK.

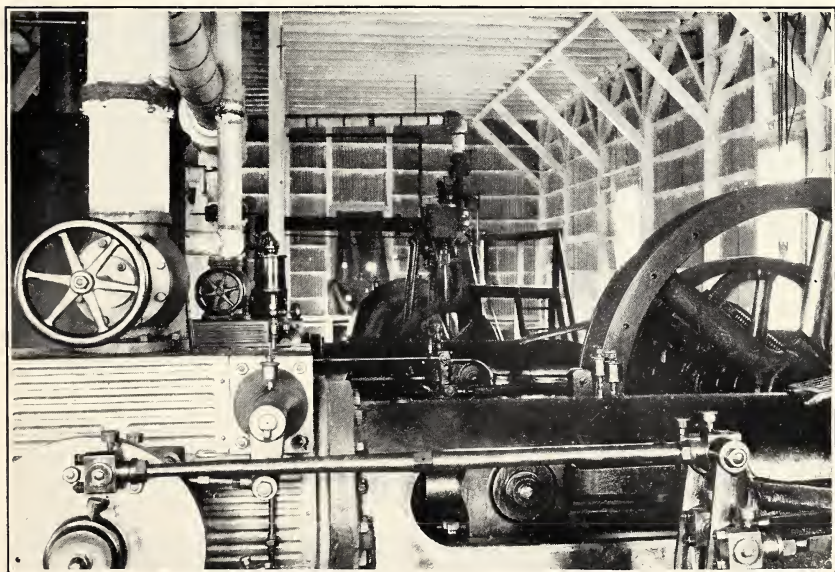


FIG. 2.—INTERIOR VIEW OF PUMPING PLANT, WILLSWOOD PLANTATION, ST. CHARLES PARISH, LA., SHOWING ARRANGEMENT OF MACHINERY.

(3) One centrifugal pump with 36-inch diameter discharge pipe, direct-connected to a double vertical engine.

Pumps 1 and 2 discharge into open flumes at an average head on pump of about 10 feet, which is about 5 feet greater than is necessary. Pump 3 has a siphon on the discharge pipe, but the end is not always submerged.

The pumping plant, with the main reservoir leading to it, is illustrated in Plate XV, figure 1, while Plate XV, figure 2, gives an

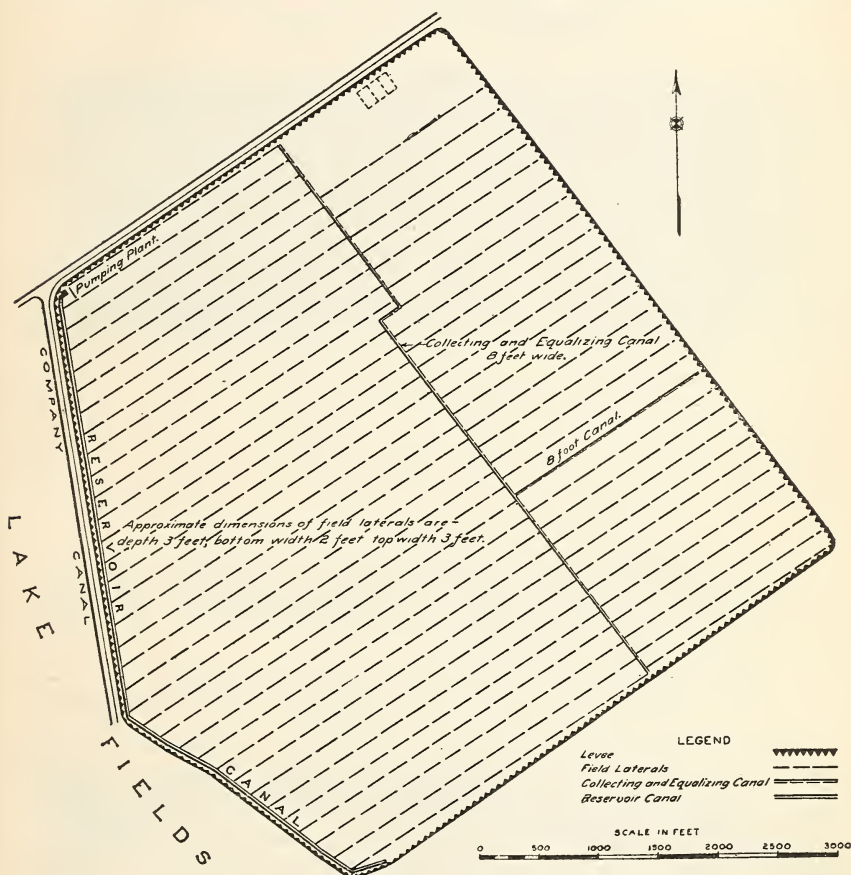


FIG. 3.—Map of Smithport plantation, Lockport, La Fourche Parish, La., showing arrangement of ditches and levees.

interior view of the pumping plant. The direct-connected centrifugal pump appears in the background.

SMITHPORT PLANTING COMPANY TRACT—647 ACRES.

This tract adjoining the village of Lockport, La Fourche Parish, has been recently reclaimed, a large portion of it from Fields Lake. Although it is all drained by well-made lateral ditches placed 200 feet apart, but a small part was put under cultivation previous to 1909. As will be seen from the map (fig. 3), the tract is well shaped and

one well adapted to a regular layout of ditches. In this respect it has the advantage of either of the other two plantations.

The pumping plant consists of two Menge pumps with impellers of 32 inches by 12 inches and 24 inches by 8 inches, running, respectively, at 230 and 330 revolutions per minute. Each pump is rope driven by a slide-valve noncondensing engine, while steam is supplied by a 100-horsepower return tubular boiler, no feed water heater being used.

DISTRICT No. 2—940 ACRES.

Located 5 miles west of the village of Raceland, La Fourche Parish, this plantation is as yet only partly under cultivation and the system of ditches is not complete. On account of a very thick top layer of humus of only partly decayed vegetation, good drainage is secured with lateral drains spaced several hundred feet apart instead of at distances as shown on the map (fig. 4).

Two 32-inch by 12-inch Menge pumps are used, one belt-driven, and the other rope-driven by two 12 by 16 slide-valve noncondensing engines. Two 60-horsepower locomotive-type boilers furnish the steam.

Plate XVI, figure 1, a typical marsh scene, shows the wild grasses common to this section. It is a view of a portion of District No. 2 before reclamation. Plate XVI, figure 2, gives a view of the same district after reclamation, showing the levee as constructed and also Bayou False, which serves as an outlet for these lands as well as for the new tract adjoining them, which is described later.

Plate XVII, figure 1, is an excellent view of a modern Menge pumping installation at La Branch, La. It is very similar to that installed for District No. 2 near Raceland.

NEW ORLEANS LAND COMPANY TRACT—1,380 ACRES.

Although inside the city limits of New Orleans, this tract has but recently been inclosed by protection levees. Originally heavily timbered with cypress and gum, there are still many of the small trees standing, and thus far only a few main canals have been dug, as is shown by figure 5. These canals vary in width from 14 to 40 feet, and interior lateral ditches will be constructed later. Drainage is secured by gravity into the city sewer system, and thus this tract differs from the other three in requiring no pumping installation.

DISTRICT No. 3—2,400 ACRES.

This is a new project lying between Raceland and Lake Fields, in La Fourche Parish, and it embraces the latest practices as to ditch arrangement and modern pumping equipment. The soil is typical turf land and the surface elevation is 3 to 6 feet above mean tide.



FIG. 1.—TYPICAL WET PRAIRIE SCENE, SHOWING WILD GRASSES. DISTRICT NO. 2, NEAR RACELAND, LA FOURCHE PARISH, LA.



FIG. 2.—DISTRICT NO. 2, NEAR RACELAND, LA FOURCHE PARISH, LA., AFTER RECLAMATION, SHOWING BAYOU FALSE, USED AS AN OUTLET FOR THESE LANDS, WITH LEVEE ON RIGHT BANK.



FIG. 1.—MODERN PUMPING PLANT AT LA BRANCH, ST. CHARLES PARISH, LA., SHOWING
OUTLET CANAL AND DISCHARGE FROM PUMPS.



FIG. 2.—OUTLET CANAL ON A LARGE SUGAR PLANT-
TATION IN SOUTHERN LOUISIANA, SHOWING IT COM-
PLETELY FILLED WITH WATER HYACINTHS.

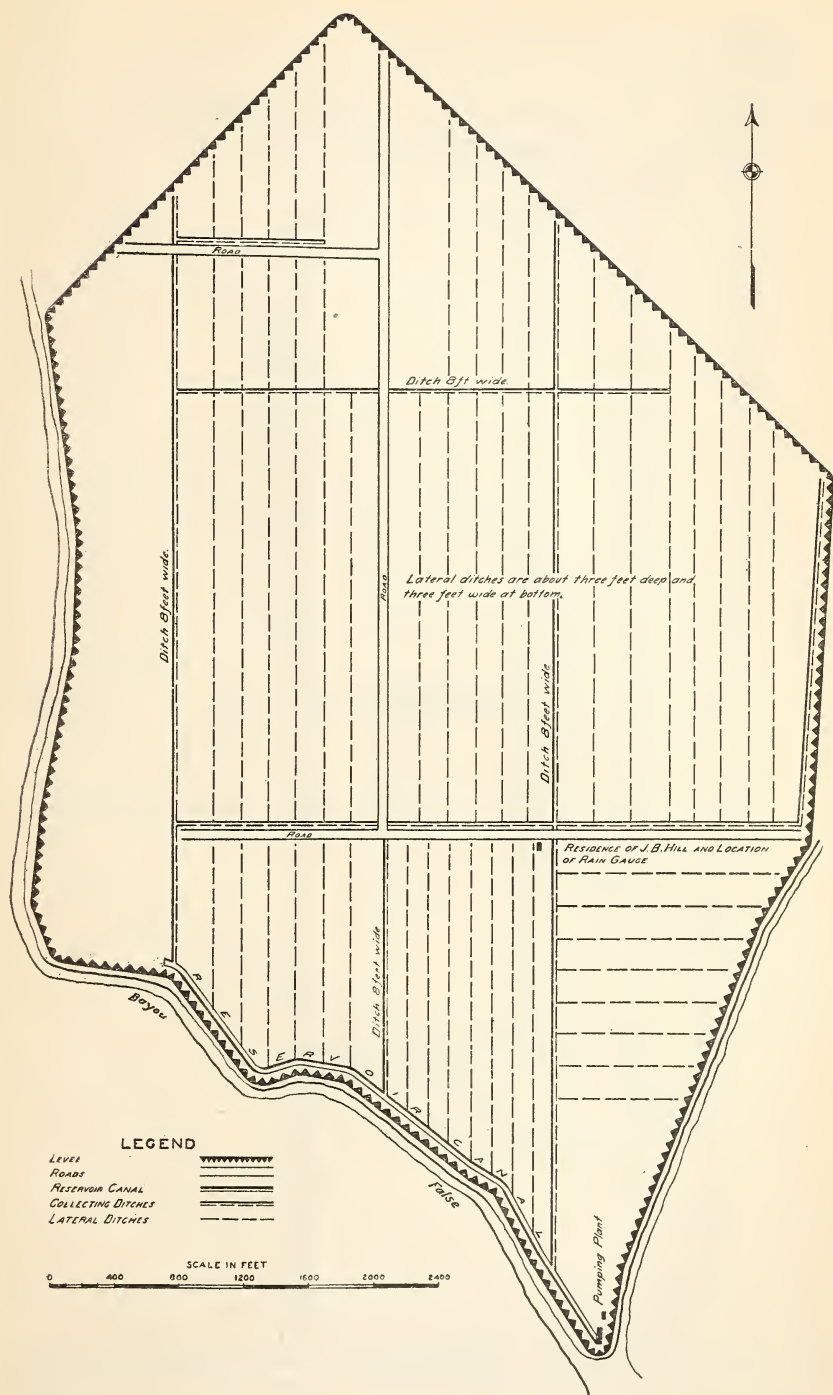


FIG. 4.—Map of Drainage District No. 2, near Raceland, La Fourche Parish, La., showing ditch and levee system.

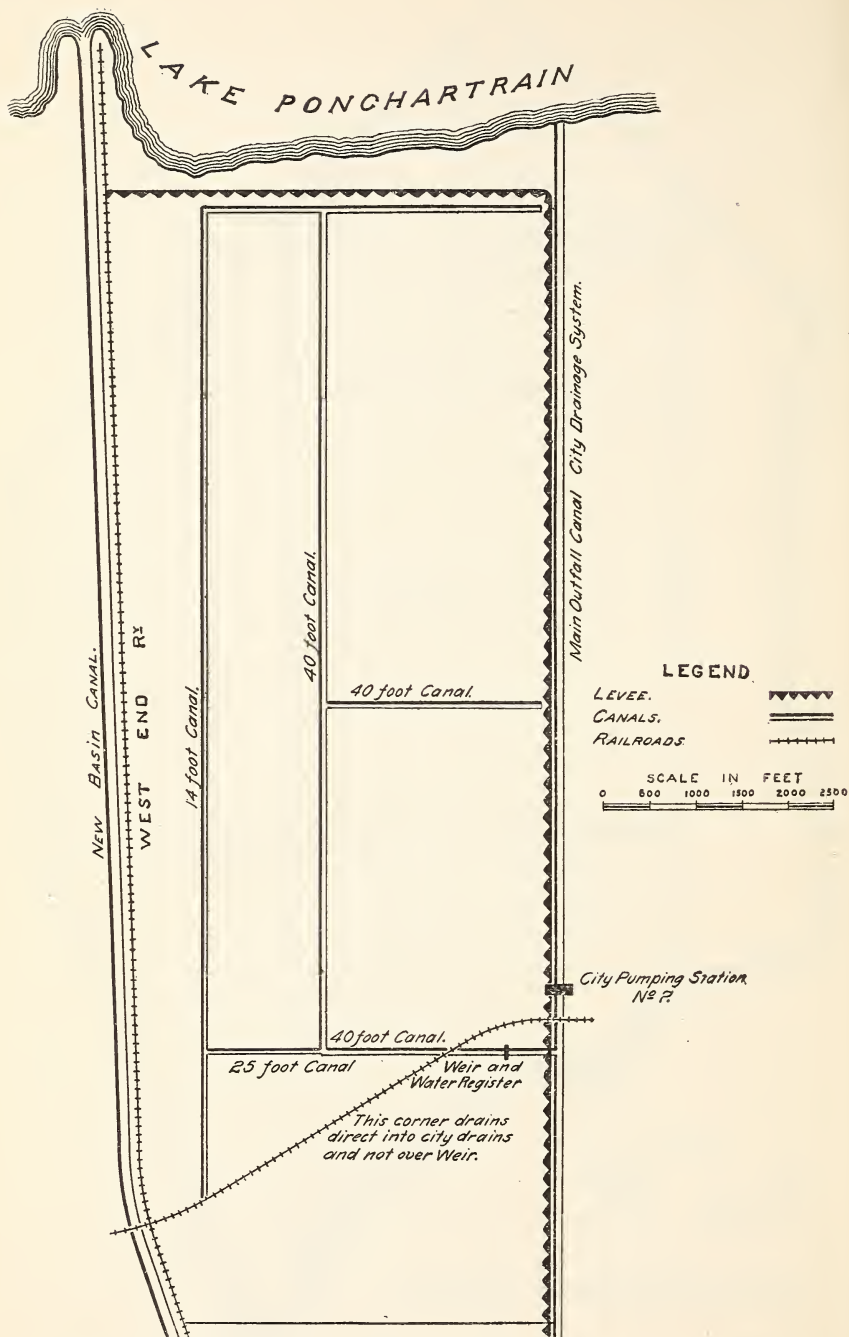


FIG. 5.—Sketch map of New Orleans Land Company tract, New Orleans, La., showing arrangement of ditches and levees.

The map (fig. 6), shows the reservoir canals which are 40 feet wide and 6 to 8 feet deep, and the collecting ditches, which have a bottom width of $2\frac{1}{2}$ to 3 feet and a depth of 4 feet. The laterals are spaced 210 feet apart, and are made 3 feet deep with bottom widths of $1\frac{1}{2}$ to 2 feet. The pumping equipment consists of two 30-inch Law-

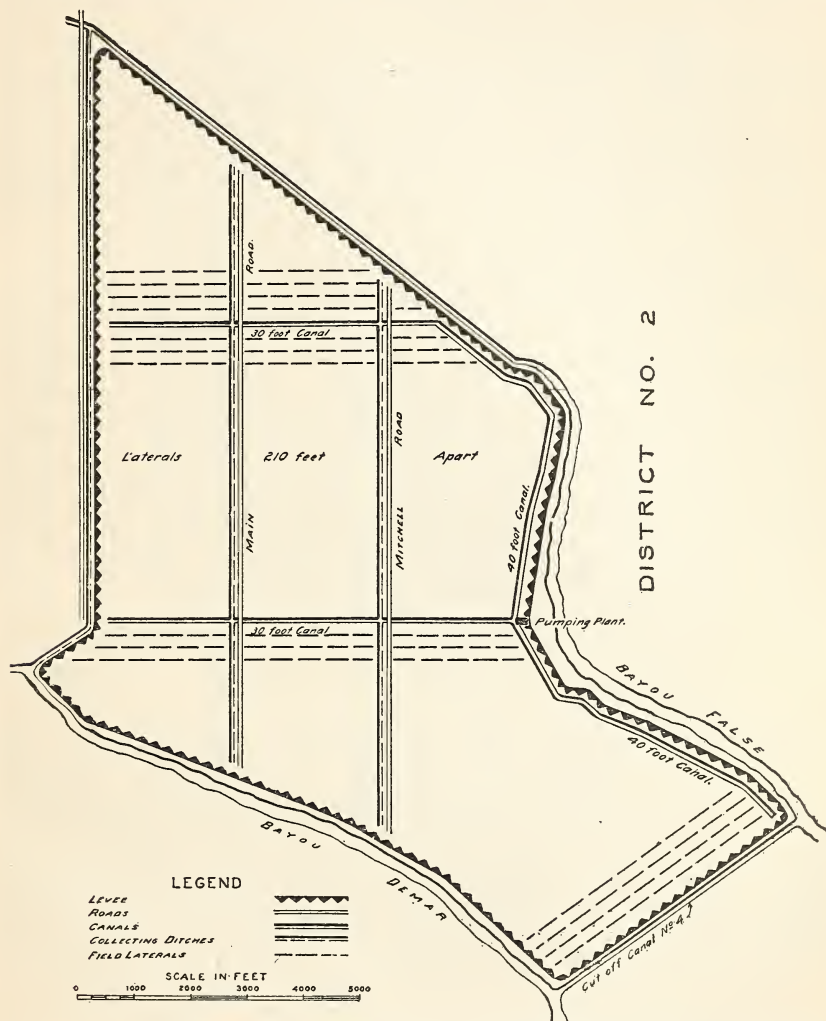


FIG. 6.—Map of Drainage District No. 3, near Raceland, La Fourche Parish, La., outlining arrangement of ditches and levees.

rence centrifugal pumps discharging under water, so that the lift varies between $2\frac{1}{2}$ and 5 feet, according to the stage of water in Bayou False, which takes the discharge. Direct-connected to the pumps are two 100-horsepower vertical engines, steam being supplied by two locomotive-type boilers.

MEASUREMENTS OF RAINFALL AND RUN-OFF.

The calculations of run-off were made from the logs kept at the various pumping plants, each pump having previously been rated. Most of the discharge flumes are rectangular in section and open at the top, permitting the use of weirs for making measurements of the water pumped. These measurements were simplified by the fact that each pumping unit was equipped with a separate discharge flume. Pumps discharging through pipes were rated by means of a Pitot tube.

The run-off from the New Orleans Land Company tract was obtained by means of weir measurements. A 4-foot weir is placed in the main ditch and discharges into a flume, which in turn empties into the drainage canal leading to city drainage station No. 7. The weir and flume are covered by a small tent house in which is located a recording gauge or water register. The cross section of the canal is large back of the weir, insuring complete contraction, so that the measurements are unusually accurate, and the Francis weir formula applies. Two rain gauges are now located on different sides of the tract and the mean of the records is used in calculations of rainfall.

Records were kept continuously from June 1, 1909, to January 1, 1910, with the exception of those of the New Orleans Land Company tract. These latter started June 16, but were interrupted on September 20, 1909, by a breaking of the city levees and the consequent shutting down of the city's pumping plants, due to the severest hurricane known to this section sweeping in from the Gulf of Mexico. Backwater from Lake Pontchartrain and the accumulation of the city drainage water prevented normal conditions from being established till October 9, when the records were continued. In the following tabulation of rainfall and run-off data the records of this storm are not included in those of the last-named tract:

Comparative rainfall and run-off data for four experimental tracts.

Month.	Smithport.				Willswood.				District No. 2.				New Orleans Land Co.		
	Inches.		Run-off per cent of rain.	No. days run of pumps.	Inches.		Run-off per cent of rain.	No. days run of pumps.	Inches.		Run-off per cent of rain.	No. days run of pumps.	Inches.		Run-off per cent of rain.
	Rain.	Run-off.			Rain.	Run-off.			Rain.	Run-off.			Rain.	Run-off.	
June.....	10.63	4.20	39.5	12	10.42	5.18	49.6	9	9.62	2.26	23.5	14	2.15	0.62	28.8
July.....	2.19	.44	20.1	2	5.64	.67	11.9	3	5.87	.63	10.7	7	6.72	.84	12.5
August....	8.62	3.42	39.7	6	7.62	2.97	39.0	9	6.68	1.24	18.6	10	5.34	1.22	22.7
September..	5.61	2.69	47.8	7	6.42	2.44	38.0	5	6.12	2.42	39.7	7	1.41	.24	17.0
October....	2.90	1.62	55.8	4	4.23	.84	19.9	5	1.98	.52	26.2	3	3.45	1.43	41.5
November..	2.00	.....	.....	.....	1.46	.50	34.2	4	.90	.08	8.8	1	1.26	.67	53.6
December..	5.26	3.44	65.4	10	6.79	3.39	49.9	10	6.05	1.35	22.3	6	7.43	4.97	66.9
Total..	36.21	15.81	43.7	41	42.58	15.99	37.6	45	37.22	8.50	22.8	48	27.76	9.99	36.0

Average percentage of run-off to rainfall for the four tracts, 35.

As the investigations cover such a short period of time, care must be exercised in making deductions from the results as shown. The records are still being continued, however, so that more reliable conclusions can be made at some later time.

It will be seen that during August the pumps in District No. 2 were operated on ten days, although the actual amount of run-off was small. This was due to the fact that it was desired to maintain

a certain stage of water to insure the successful operation of an hydraulic dredge which was engaged in clearing and deepening the reservoir canal.

The data which have been collected would indicate that a much greater run-off may be expected from the better ditched and fully cultivated lands than from those that are more nearly in a natural state. While this may be true, it is probable that a long series of uninterrupted records will show a less striking variation. It will be noted that the records on the New Orleans Land Company tract did not begin until the effects of the 5-inch rainfall of the first part of June had passed and that they were suspended during and after the severe storm of September 20, thus not including the heaviest storms of the season, with the exception of that of December, when the rainfall was heavy and mostly fell in a few hours' time, thus giving the largest percentage of run-off of any recorded. The decreased evaporation of December no doubt also increased the run-off.

Owing to the fact that at times of extreme high water a few acres are drained by gravity on the Willswood plantation, it is probable that the run-off records for that tract show a slightly less quantity than they should.

The fact is well known that very heavy storms cause a larger percentage of run-off than smaller ones, but for storms of all magnitudes there is a variation in the ratio of run-off to rainfall, due to the varying conditions of the soil and to its character and state of moisture, the duration of the storm, amount of evaporation and seepage, slope of ditches and fields, and arrangement and capacity of reservoirs, manner of pumping, and probably to other causes not yet determined. In the table below, the records of a few typical heavy storms are presented for the Smithport and Willswood plantations, as they more nearly represent normal agricultural conditions than the two other experimental tracts and they also were under the closest observation. On account of the effects of preceding and succeeding storms it is difficult always to determine the effect of a single storm, consequently errors are liable to arise. It will be seen that the percentages for the two tracts are very nearly equal and that the combined percentage of 50.8 for the three storms recorded is much higher than the combined percentage of 35 for the four tracts for the six-months period shown in the table on page 426.

Precipitation and run-off from heavy storms, Smithport and Willswood plantations.

	Smithport.		Willswood.	
	Precipitation.	Run-off.	Precipitation.	Run-off.
	<i>Inches.</i>	<i>Inches.</i>	<i>Inches.</i>	<i>Inches.</i>
June 1 to 5.....	5.34	2.33	5.25	3.29
September 19 to 30.....	3.95	2.70	4.44	2.29
October 19 to 31.....	2.23	1.00	3.00	.68
Total.....	11.52	6.03	12.69	6.26

Total for both stations: Precipitation, 24.21; run-off, 12.29. Ratio of run-off to precipitation, 50.8 per cent.

A comparison of the effect of heavy and light storms, respectively, may be made from the following table, which gives the daily rainfall and run-off record from June to October, inclusive, for the Willswood plantation, as well as the corresponding heights of water in the reservoir canal.

Excepting as affected for short periods by rains and by pumping, the height of water in the reservoir canals represents fairly accurately the height of ground water of the lower lands. This is notably true of the Willswood tract, where the lowlands are porous and allow a quick adjustment of water level following a change in level in the canals. As an indication of the effect of evaporation, including the transpiration of the vegetation, the record for the month of July, as shown in the table below, is especially interesting. The month was begun with the soil well moistened by showers late in June, yet, with a precipitation of 1.17 inches from July 1 to 19 there was a rise of only $2\frac{1}{2}$ inches in the reservoir, while from July 5 to 19, with a precipitation of 0.99 inch, there was an actual lowering of the water level in the canal.

Daily rainfall and run-off, Willswood plantation.^a

Day.	June.		July.			August.			September.			October.		
	Rainfall.	Run-off.	Rainfall.	Run-off.	Reservoir gauge.	Rainfall.	Run-off.	Reservoir gauge.	Rainfall.	Run-off.	Reservoir gauge.	Rainfall.	Run-off.	Reservoir gauge.
	In.	In.	In.	In.	Ft. in.	In.	In.	Ft. in.	In.	In.	Ft. in.	In.	In.	Ft. in.
1.....	0.15		0.12		4 7	0.56		4 9			4 2			4 9
2.....	4.10	0.88	.04		4 8½	.48	0.20	5 3						
3.....	1.00	1.42	.02		4 9			3 7						
4.....		.76			4 9½			4 1½						
5.....		.23			4 10			4 11½						
6.....			.03		4 10½			5 1						
7.....					4 10½	.63		5 1½				0.35		4 9
8.....						.07			0.53					
9.....		.27				1.70						.10		4 10
10.....			.22			1.12	.60	5 2½				.78		5 1
11.....			.05				.68							
12.....			.15		4 10½	.83	.42	4 4½					0.16	5 2
13.....	.25				4 10½	.26	.30	5 3	1.40		4 9			3 8
14.....	.49				4 9½		.26	5 3½		0.15				
15.....			.02		4 9½			3 8			3 2			
16.....					4 9½				.05		3 4½			4 0
17.....			.32		4 9½						3 5½			
18.....	.20		.20		4 9½									
19.....	.93				4 9½						3 6½	2.04		4 2
20.....	1.22	.51	1.48		5 0			4 11½	4.14	1.03	4 5	.96	.29	
21.....	.43	.43		0.20	5 0½	.06	.14	5 0	.30	.74	3 9		.20	5 2
22.....	.06	.47			3 3			3 5		.34	5 6			4 6
23.....	.40				3 5½	1.11		3 6½			4 3			
24.....	.04		.02		3 7	.10		4 2½		.18	5 1½			
25.....					3 8		.17	5 5			3 11	.19		5 2
26.....		.21	.50		3 9	.70		4 2						3 6
27.....	.32		.14		3 11½			4 11½						3 8
28.....	.17		2.24	.20	4 0½		.20	5 3½						4 0
29.....				.27	4 9			3 7						4 3
30.....					3 6			3 8			4 8			4 6
31.....			.09		4 3			4 0						4 8
	10.42	5.18	5.64	.67	.....	7.62	2.97	.....	6.42	2.44	.....	4.23	0.84	.....

^a Taken from report by A. M. Shaw.

A few records of pumping operations are available, covering a greater length of time than those given above, but the lack of essential details makes them of little value for the purpose of the calculation of run-off. An approximate idea can be gained, however, as to the amount of pumping necessary in order to maintain the water

table at the proper height for profitable cultivation. The table below gives the daily pumping record of the Willswood plantation for 1907 and 1908 and was compiled by Mr. Shaw from the diary of the engineer in charge of the pumping plant. In the last column is given the corresponding monthly rainfall for the entire period. Comparing the two years, it is seen that during 1907 it took 14.8 hours' pumping for each inch of the 66.32 inches of rainfall, whereas in 1908 the pumps ran 12.9 hours per inch for the 51.06 inches of rainfall in that year. This on its face would seem to indicate that the uneven distribution of the rainfall throughout the year, as well as the fact that one part of the plantation may receive a very heavy precipitation during certain storms while only a small shower may affect the rest of the land, has but slight effect on the general yearly average, and that year by year the ratio of the necessary pumping to the rainfall will be fairly constant.

Daily pumping record for 1907 and 1908, Willswood plantation.

Month.	Day of month.																			
	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.
1907.																				
January.....														12				12		
February.....															12					
March.....	12			12							12									
April.....	6																			
May.....	12	18	6				9	12	12	12	9	9		12						9
June.....	18	9	9												6					
July.....																				
August.....																				
September.....																				
October.....								12		9										
November.....						12												12		
December.....				12					12		12		12	18	18		12	12		9
1908.																				
January.....	12			9		18	18		12	12	12		12			12				
February.....			12						18	24	18				12			6		
March.....																				
April.....	12														12	12				
May.....					6	18								6	12					
June.....	6														12					
July.....	12																			
August.....	12	12	6	12	12			6											12	
September.....														12					9	12
October.....																				
November.....								12												
December.....																				

Month.	Day of month.											Total hours run.	Total days run.	Total rainfall.
	21.	22.	23.	24.	25.	26.	27.	28.	29.	30.	31.			
1907.														
January.....					6	6						36	4	2.14
February.....					12	12	12					48	4	4.47
March.....												36	3	2.30
April.....		18	18	12	12	24	24	24	24	24		196	10	13.18
May.....			12	12	12				6	12	12	174	16	14.74
June.....			12									66	6	.98
July.....												0	0	4.47
August.....			12									12	1	5.28
September.....							12		9			31	2	5.31
October.....												31	2	1.61
November.....	18	12	6		12					12	12	108	9	4.96
December.....	18	24	24		24	24	12			12		243	15	6.88
Total.....												981	72	66.32

Daily pumping record for 1907 and 1908, Willswood plantation—Continued.

Month.	Day of month.											Total hours run.	Total days run.	Total rainfall.
	21.	22.	23.	24.	25.	26.	27.	28.	29.	30.	31.			
1908.														
January.....	12							12				151	11	4.50
February.....	12				9							111	8	4.14
March.....			6	9		12						27	3	3.28
April.....					6							42	4	1.34
May.....	12											54	5	4.77
June.....								12	12	12		54	5	2.39
July.....												12	1	11.03
August.....												72	7	5.65
September.....		18	18			12		12		12		105	8	10.70
October.....												0	0	.78
November.....							6					18	2	.69
December.....	12											12	1	1.79
Total.....												658	55	51.06

The mean annual rainfall at New Orleans amounts to 57 inches. There is a slight increase in precipitation in the extreme southeastern part of the State, while it drops off to about 50 inches at Cameron, which is in the western part near the Gulf coast. At Shreveport, about 200 miles from the Gulf of Mexico, the average precipitation is 46 inches. The table below gives the rainfall by months for the past thirty-eight years as recorded by the United States Weather Bureau Office in New Orleans.

Monthly rainfall record, United States Weather Bureau Station, New Orleans.

Year.	Monthly and annual precipitation.												
	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>
1871.....	6.75	1.59	4.47	2.29	5.08	8.61	4.34	7.21	6.59	9.09	7.14	1.46	64.62
1872.....	5.10	4.77	9.18	5.01	3.14	5.34	6.43	3.75	2.10	3.18	7.43	5.25	60.68
1873.....	5.06	1.93	5.10	1.74	^a 18.68	6.68	5.22	8.30	3.21	1.89	5.95	1.79	65.55
1874.....	1.68	3.68	5.37	13.62	.22	9.62	^a 12.93	4.82	4.21	^b T.	1.12	3.27	62.74
1875.....	8.44	^a 13.85	10.84	8.05	2.53	4.92	6.57	8.61	7.89	2.09	6.79	5.15	^a 85.73
1876.....	4.43	8.20	11.32	6.41	7.10	6.20	4.73	4.44	.26	.24	4.35	9.57	67.25
1877.....	5.30	.98	4.94	4.79	1.48	2.75	6.41	2.54	13.21	^a 9.15	6.58	4.96	63.09
1878.....	5.36	3.50	4.63	1.51	8.11	7.35	6.21	5.31	2.64	5.07	^a 7.78	8.69	66.16
1879.....	2.34	2.13	1.36	9.17	4.63	2.96	7.04	10.44	3.15	1.36	3.79	2.90	51.27
1880.....	1.02	4.62	6.66	6.88	6.55	6.43	11.22	4.60	7.48	1.88	6.04	6.45	69.83
1881.....	^a 11.15	5.80	2.75	3.92	3.20	2.84	6.97	4.21	4.47	4.84	7.24	6.62	64.01
1882.....	4.54	4.04	.92	4.83	6.83	2.71	6.84	9.47	1.59	2.16	1.98	4.27	50.18
1883.....	10.63	1.59	5.01	^a 14.20	5.41	^a 12.05	3.33	4.12	^b .25	3.43	6.36	3.47	69.85
1884.....	4.35	3.16	8.24	6.48	4.33	8.60	4.12	^b .87	3.12	5.60	3.13	8.01	60.01
1885.....	9.70	2.39	6.99	3.67	5.77	3.30	6.15	4.25	13.55	.56	3.47	4.88	64.18
1886.....	7.53	1.96	8.41	5.60	3.07	9.30	4.35	2.40	4.09	.22	5.33	2.57	54.83
1887.....	4.26	5.58	3.37	1.87	3.99	11.33	7.85	7.42	6.51	4.71	.52	7.56	64.97
1888.....	3.29	11.21	6.45	1.89	9.75	9.09	^b 2.02	^a 22.74	4.15	7.36	1.50	3.68	83.13
1889.....	6.51	2.78	3.86	2.28	1.17	7.62	9.13	5.59	6.40	.26	2.18	^b .67	48.45
1890.....	^b .66	2.27	1.45	3.46	5.32	7.71	6.59	3.62	2.85	5.24	.42	2.58	42.17
1891.....	3.75	7.42	2.67	^b .26	.76	4.45	4.57	1.69	3.43	2.38	3.31	3.93	38.62
1892.....	5.87	^b .04	2.82	10.44	2.62	5.46	7.46	6.96	6.33	2.14	3.55	3.22	56.91
1893.....	2.50	4.92	3.49	3.70	2.66	5.30	3.72	4.56	4.38	4.24	6.24	2.31	48.02
1894.....	1.76	11.06	5.94	4.71	1.79	5.19	11.51	7.32	.92	.89	1.34	2.01	54.44
1895.....	7.19	3.92	3.81	2.58	7.95	9.74	6.07	6.79	1.97	1.21	.69	4.52	56.44
1896.....	2.33	2.78	5.29	4.84	2.80	8.23	2.92	3.31	5.26	5.33	2.82	3.77	49.68
1897.....	1.92	4.82	4.82	5.75	.25	5.82	4.70	3.12	3.19	2.70	3.38	4.00	43.47
1898.....	1.71	6.20	^b .80	2.80	^b .02	3.79	4.57	6.24	^a 13.90	1.77	5.17	2.03	49.00
1899.....	2.44	2.93	2.71	1.56	.14	7.80	5.45	2.31	.35	.89	1.70	2.79	631.07
1900.....	3.69	5.46	4.00	10.69	2.91	5.10	6.06	4.19	3.76	3.55	1.29	5.61	56.33
1901.....	4.24	5.78	4.26	7.79	1.08	4.46	10.71	5.80	3.30	2.67	2.78	4.87	57.73
1902.....	.97	3.83	4.07	3.71	1.56	1.46	4.24	2.93	6.68	2.42	3.65	6.09	41.61
1903.....	4.01	10.20	^a 14.61	.97	1.11	3.61	7.17	7.48	3.32	.81	^b .13	3.71	57.18
1904.....	3.58	1.52	4.12	1.94	4.31	5.59	8.49	5.83	2.84	1.20	1.90	2.37	43.69
1905.....	6.31	5.32	7.80	5.89	4.23	7.55	3.93	3.95	11.09	5.95	3.62	^a 14.43	80.07
1906.....	2.57	2.25	5.53	1.08	.70	4.39	7.32	4.88	7.40	1.08	1.03	3.36	41.59
1907.....	2.14	4.47	2.30	13.18	14.74	^b .98	4.47	5.28	5.31	1.61	4.96	6.88	66.32
1908.....	4.50	4.14	3.28	1.34	4.77	2.39	11.03	5.65	10.70	.78	.69	1.79	51.06
Mean.....	4.46	4.56	5.10	5.02	4.23	5.94	6.39	5.61	5.05	2.89	3.62	4.50	57.42

^a Highest monthly and annual.^b Lowest monthly and annual.

METHODS OF RECLAMATION.

EARLY METHODS.

Some years ago systematic efforts looking toward the reclamation of these fertile marsh lands began, and it is interesting to note that as early as 1883-84, 1,300 acres were reclaimed by one company. During the great flood of 1884, however, the levees were broken and further work ceased for the time. Later, Mr. J. B. Watkins reclaimed a large area in southwestern Louisiana, and in "Tide Marshes of the United States"^a he gives the following description of his methods:

Our plan of reclamation is to build dikes along the Gulf, rivers, lakes, and bayous of sufficient height and strength to prevent overflow of each in the event of floods from rain and storm tides, and in this we will be assisted by the natural levees found in many places along these waters. We cut, parallel to each other, and one-half mile apart, canals 18 feet wide and 6 feet deep. At right angles with these, at intervals of $2\frac{1}{2}$ miles, we cut larger canals, thus forming the land into oblong blocks one-half mile by $2\frac{1}{2}$ miles, each containing 800 acres. Across these blocks at proper intervals we cut lateral ditches 30 inches deep by 8 inches wide at the bottom, flared to 30 inches wide at the top.

The canals are cut, the levees formed, and the dikes are, to a considerable extent, built by the use of powerful floating steam dredges. Smaller ditches are cut by ditchers propelled by steam power, passing through but once, at the rate of $1\frac{1}{2}$ miles per hour.

At proper localities we erect automatic flood gates, by means of which we control the stage of water in the canals, and the necessary volume of water is regulated to some extent by the ebb and flow of the tide. This is supplemented by the use of powerful wind pumps, and when the natural elements will not accomplish the work we readily move upon the canals to the spot our ditching, plowing, and cultivating engines and attach them to pumps. Thus arranged, with control of the water, these blocks of land are in condition for the most successful rice culture.

In the rice and sugar belt, in the southern part of the State, the land ranges from 2 to 8 feet or more above mean gulf level, and the swamps, bayous, bays, and rivers with which the section is interspersed furnish the outlet system by which the drainage water may be carried to the Gulf. In a majority of cases it is necessary to levee a part or all of a plantation in order to protect it from the overflows in times of flood, and, also, in regions near the gulf coast, to protect it from backwater and high tides, especially at times when the prevailing southeast winds are blowing. At such times the waters along inland streams near the coast may be raised as much as from 3 to 5 feet from this cause. In this connection might be mentioned the fact that on the Matthews plantation in La Fourche Parish it was considered that usually the pumps had to operate only after a rainfall of 4 inches or more in twenty-four hours, but when the southern winds made high tides in the bayou they were started for as small as a 2-inch rainfall.

Until very recent years the ditch systems for the reclamation of sugar lands were nearly identical. Often it seemed that the chief

^a U. S. Dept. Agr., Misc. Spec. Rpt. 7.

effort was simply to rid the land of the rainfall without much regard as to whether or not the drainage of the soil was secured. As most of the plantations ran from the bayous or streams back into the swamp, there was usually at least a slight fall away from the streams, and a series of parallel "leading" ditches from 6 to 10 feet wide and 2 to 4 feet deep, spaced from 800 to 1,200 feet apart, ran the length of the plantation. These were intersected at right angles, usually by ditches of similar size, at distances of 800 to 1,200 feet apart. These latter ditches were laid with no fall, so that the water would flow either way, dependent upon the height of the water surface in the "leading" ditches. Smaller "panel" ditches, 2 to 6 feet wide, $1\frac{1}{2}$ to 3 feet deep, and placed every 90 to 120 feet, ran parallel to the leading ditches, thus dividing the land into blocks, locally known as "cuts." The cultivation of the crop was in rows parallel to these panel ditches and every 300 to 400 feet the furrows were crossed by shallow shovel ditches, known as "quarter drains," which caught the run-off from the furrows and led it into the panel ditches. After each cultivation it was necessary to go over these shallow drains with a shovel, in order to clear them out and make them effective. Large rainfalls were quickly disposed of by such a ditch system, but, owing to the shallow depth of the ditches, the drainage of the soil was not as effective as under more modern systems, and from 10 to 20 per cent of the cultivable area was taken up by the ditches, besides the inconvenience caused by the smallness of the plats to be cultivated. The cost of such a ditch system, not including levees or pumping equipment, would amount to over \$2,000 for 80 acres, or an average of over \$25 per acre.

PRESENT METHODS.

It is apparent from the experiences of the past that in the reclamation of small areas of land the cost might often be prohibitive, but as the size of the plantation increases, the cost per acre rapidly diminishes and probably approaches a minimum price when the plat of ground amounts to eight sections (5,120 acres) of land or more. Under ordinary circumstances, however, it would be difficult to find such a tract of land lying in regular shape and available for reclamation, hence there are few single projects thus far which have attained this size, although the impetus recently received in the matter of reclamation of these lands indicates that the undertakings will become larger and larger. The various main elements which enter into these projects are the levee system, seepage, outlet canal system, interior ditch system, and, lastly, the pumping plant.

LEVEES AND SEEPAGE.

Sometimes the natural embankment or high ground adjacent to the bayou or river makes a levee unnecessary along the stream side of the plantation, but ordinarily the other three sides need such protection, wholly or in part, the height of the levees depending in large measure upon the proximity to the Gulf and upon the elevation of the land surface respective to the high water in times of flood. Ordinarily the levees do not require such careful construction as those along streams subject to frequent and prolonged floods where the water often stands against the embankment for long periods, nor is it always so necessary to clean the entire levee site as in this latter case. It is always well, however, to remove all coarse vegetable matter, and a plowing up of the site is very desirable, in order to insure a good bond. The general specifications for levee construction and maintenance have been given in a previous publication of this Office.^a A muck ditch 2 or 3 feet in width and about 2 feet in depth, and approximately on the center line of the proposed levee, should be constructed, in order to insure against excessive seepage. Such seepage is liable to be the minimum in the fine close-textured silt soil back in the marshes. In the case of the Gheens plantation, La Fourche Parish, 2 parallel muck ditches spaced 25 feet apart are used under the levee.

Shrinkage of the levee should also be taken into account, and experience would indicate that levees in these soils built by means of shovels or wheelbarrows shrink about one-fifth of their gross height, while those constructed by wheel scrapers shrink one-eighth in height. Where an excavating machine is used in dry material the shrinkage is approximately one-sixth and where excavated material is wet it is probably not more than one-tenth. In the latter case the spoil generally being from a greater depth and being well compacted during the construction usually insures less seepage than where hand work is performed and where the levee is constructed from the looser, coarser material nearer the surface. In order to prevent excessive seepage, it is preferable in constructing the levees to excavate the canals on the outside, leaving a sufficiently wide berm to prevent the spoil from sloughing back into the ditches. Unless care is exercised this is especially liable to occur in the soft prairie lands. The levees require for the first few years frequent additions in order to keep them to the required height, unless, when first constructed, shrinkage has been allowed for. In order to maintain them with as little care as possible, it is well to have them sodded to Bermuda or some native grass, which not only prevents them from washing, but also

^a U. S. Dept. Agr., Office Expt. Stas. Bul. 158, Sep. 9.

prevents the growth of weeds, brush, and other vegetation that would furnish shelter to the many burrowing animals which, ordinarily, occasion much annoyance and also damage to the levees. The sudden rise of outside waters often endangers levees on account of the increased seepage at such times, which is probably often due rather to the more porous nature of the soil above the ordinary water level than to the increased head. Such floods, however, develop all weak spots caused by muskrat holes and the like. When a failure occurs from this cause the outer end of the break should be immediately closed by a few shovelfuls of clay, planks, or sacks of earth, and a trench then dug across the levee. The tunnel made by the animal can then be filled with puddled clay and the damage thus remedied.

CANAL SYSTEMS.

Where a plantation does not adjoin a bayou or other good outlet, it is often necessary to construct outfall canals for some distance, often through heavy timber, which, of course, greatly increases the cost of the reclamation work and calls for the cooperation of a number of landowners in order to make the plan feasible. These outfall canals, as well as those surrounding the levees, furnish good means of transportation by boat, and often the flow of water from the drainage plant will be sufficient to keep them scoured out, so that they require little attention. Such transportation routes, connecting, as they do, with a series of lakes, bayous, and streams, place the various plantations in a comparatively independent attitude, so, even though not furnished with convenient railroad facilities, they are still within easy and convenient reach of good markets. Plate XVIII, figure 1, shows such a canal constructed as an outlet for two drainage districts. The small canal shown forms the reservoir of one of these districts and, as shown by Plate XVIII, figure 2, it has been cut off from the outfall canal by an earth dam and the pumping plant, as appears, is in process of erection. Along the banks of these canals willows and cottonwoods, brush and weeds often grow, but as they are above water level they do not, as a rule, offer much interference to the flow of the stream. Another growth, however, that causes a great amount of annoyance and in some cases practically stops the flow of the water in the ditches is the water hyacinth, which is known locally as a lily. It is practically impossible to navigate through these obstructions, when once well established, except by the use of stern-wheel power boats. These plants, introduced from abroad, have rapidly spread through many of the southern streams, so that means for checking their growth or eradicating them entirely are eagerly sought. Plate XVII, figure 2, page 422, shows a canal filled with these water hyacinths which have grown to about 18 inches above the water surface. The view shows the main discharge canal of a



FIG. 1.—CONSTRUCTED CANAL SERVING AS OUTLET FOR TWO DISTRICTS AND AFFORDING GOOD TRANSPORTATION FACILITIES.



FIG. 2.—SAME VIEW AS FIG. 1, BUT SHOWING RESERVOIR CANAL OF DRAINAGE DISTRICT DAMMED ACROSS AND PUMPING PLANT BEING ERECTED.

large plantation, and it can readily be understood how its efficiency is impaired by this pest. The following description of the plant is taken from a report by F. F. Shafer, drainage engineer:

The plant when young has a bulbous stem, but as this grows upward the enlargement disappears, apparently being absorbed by the stem, which is cylindrical and hollow. The plant multiplies rapidly by sending out shoots or suckers from the base of the bulb, the shoots and roots seeming to start from the same place. The latter grow in feather-shaped tufts, presenting a large surface to the water. They are tender and break off readily, but, if not disturbed, grow downward 4 or 5 feet. In the latter part of May a flowering stem appears which bears a spike of odorless flowers, pale lavender in color, resembling the ordinary cultivated hyacinth. The stems reach a diameter of one-half to three-fourths of an inch and in this vicinity frequently extend 3 feet above the water surface. Crowding does not seem to hinder the growth of the plant, and since it floats upon the surface of the water, wind, tide, and currents tend to produce closely packed masses. When a ditch becomes filled with these plants, the floating stems and roots offer a very serious obstruction to the flow of water. Two or three years of undisturbed growth in a ditch will greatly reduce its usefulness as a drainage channel. Booms are placed at the outlets of the drainage canals to prevent the plants from floating into the ditches, but it is difficult to prevent these booms being left open by people passing through in boats.

The attempt has been made to use poisonous chemicals for the eradication of these plants; this not only proved more or less ineffective, but the expense was far too great. On the Matthews plantation, before mentioned, an attachment in the shape of a gridiron some 7 by 8 feet in size was fastened to the dredge dipper and the plants dipped up and dumped on the banks in a similar manner to the operation of a dipper. The plants, when exposed to the hot sun, soon die. The cost of removal by this method amounts to about 0.4 cent per square yard for the area cleaned. On other plantations, during the rainy periods the laborers use pitchforks to remove the water hyacinths from the ditches. It is often necessary to repeat the operation once or twice a month. The cost in this case is practically the same as by the use of the machine. In localities close to the Gulf, where salt water prevails, the plants do not thrive.

INTERIOR DITCH SYSTEMS.

Although somewhat dependent upon the size and shape of the area inclosed within the levees, the present general scheme of drainage is more or less the same throughout this region. This system usually includes a main "reservoir" canal, or canals, upon which, at some convenient place, a pumping plant is installed. Leading into these reservoirs are "collecting" ditches of somewhat smaller size, and at right angles to these latter are "lateral" ditches which are still smaller, and which usually feed into the collecting ditches, as illustrated by the Willswood plantation shown in figure 2 (p. 420). In certain cases, as is shown by the plan of the Smithport plantation in figure 3 (p. 421), the collecting ditches are practically dispensed with

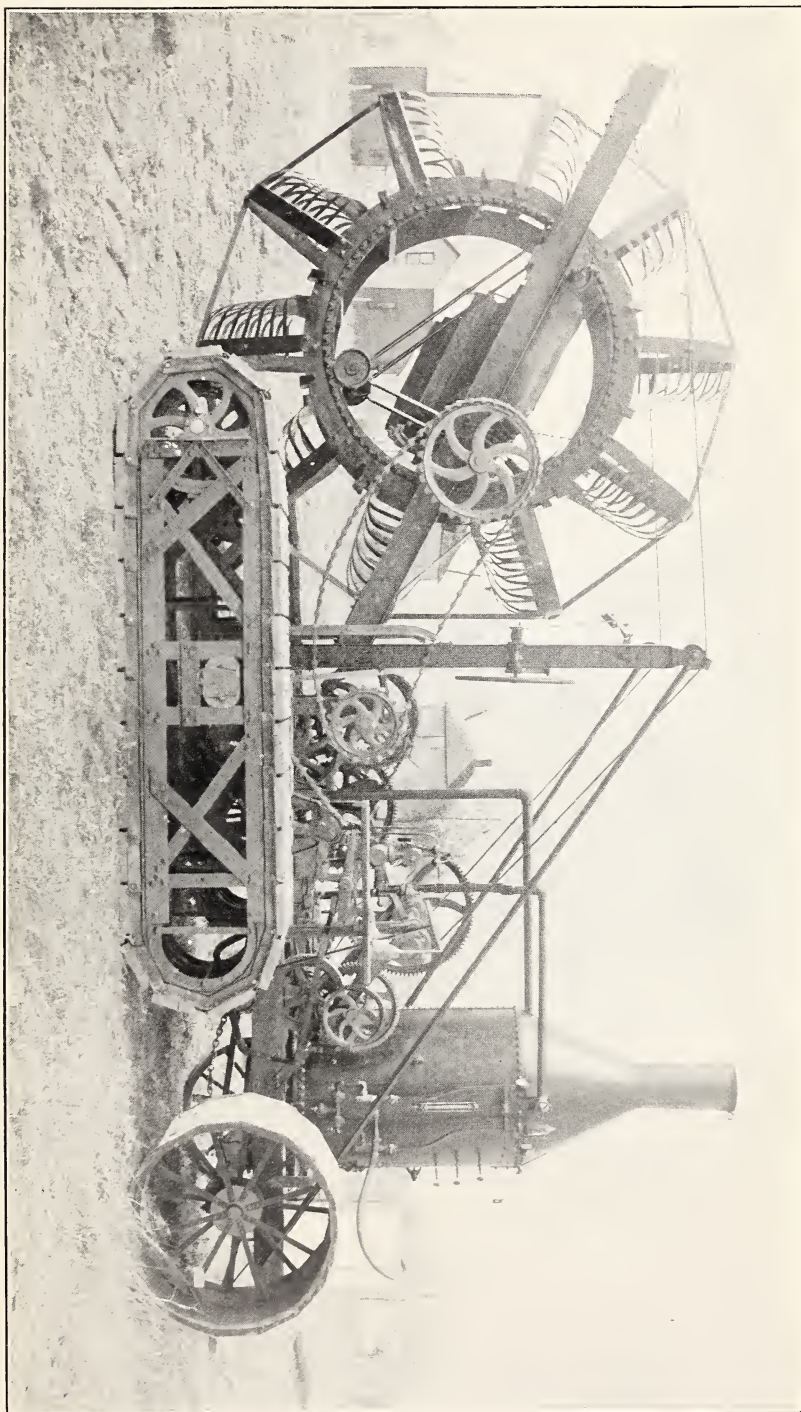
and the lateral ditches discharge directly into the reservoirs. In addition to the laterals, shallow shovel ditches, corresponding to the old "quarter drains," are maintained at right angles to the furrows, and thus collect the water rapidly from the fields and discharge it into the ditch system. These latter are made new each year and they vary in arrangement and size to meet the individual requirements.

Although subject to variation, the main reservoir canals range in width from 30 to 60 feet and usually have a depth of from 5 to 8 feet. The deeper the canal the greater storage capacity it possesses and the better outlet it furnishes for the collecting ditches or laterals, as the case may be, and it is also less liable to water-growth obstructions. As shown in the following table, the reservoirs of the three plantations under investigation have varying capacities, equivalent to a rainfall on the tributary lands of from 0.1 inch to 0.4 inch. It would seem preferable to construct reservoirs having even greater capacity than the larger amount mentioned, as, by so doing, the size of the pumping plant can be decreased. This table from Mr. Shaw's report, besides showing the reservoir capacity, also gives the length of the various ditches and area occupied by them and gives, as well, the normal capacity of the pumping plant in inches of water depth per twenty-four hours. It will be noticed that the ditch systems of these three plantations only occupy from 3 to 6 per cent of the area, which is a decided decrease from the 10 and 20 per cent under the old ditching system, as previously mentioned.

Data of ditch systems.

Description.	Smithport.		Willswood.		District No. 2.	
	Length.	Area.	Length.	Area.	Length.	Area.
	<i>Miles.</i>	<i>Acres.</i>	<i>Miles.</i>	<i>Acres.</i>	<i>Miles.</i>	<i>Acres.</i>
Reservoirs.....	1.23	6.6	4.98	24.2	1.00	4.9
Collecting canals.....	1.38	2.0	17.16	24.9	7.31	10.0
Laterals.....	29.57	21.5	125.19	91.1	18.55	13.5
Total.....	32.18	30.1	147.33	140.2	26.86	28.4
Proportion occupied by ditches...per cent..		4.65		5.84		3.02
Capacity of reservoir at flood stage in inches of rainfall over entire area.....		0.34		0.37		.09
Approximate normal capacity of pumping plant in inches per 24 hours.....		1.11		1.45		1.23

The arrangement of the collecting ditches largely depends upon the shape of the fields and the natural topography of the land, and also upon the method and kind of cultivation that is desired. The endeavor is to arrange them, however, so that they may get the water from the fields into the reservoir canals as promptly as possible. They vary from 4 to 10 feet in width and are usually maintained at a depth of from 4 to 5 feet.



OPEN TRACTION DITCHER USED FOR DIGGING LATERAL DITCHES IN WET PRAIRIE LANDS. SOIL IS DEPOSITED AT ONE SIDE OF DITCH, LEAVING GOOD BERM.

Ordinarily, the lateral ditches in heavy soils are placed 100 feet apart and are dug some 3 feet deep, with bottom width of about 2 feet and a top width of about 4 feet. Formerly these laterals were dug entirely by hand, but a ditcher machine has been developed which now digs them with great rapidity as well as economy. A view of this machine may be seen in Plate XIX. All the larger ditches are constructed usually by floating dipper dredges having 1 or 1½ yard dippers, and the present contract price is about 7 cents per cubic yard.^a

Thus far drain tile has not been extensively used in this locality, as the nature of the soil and the slopes found are likely to introduce difficulties which will have to be overcome before underdrainage is universally adopted. It is probable that in the coarser, looser soils near the bayous and streams tile would be more effective than in the more impervious silt farther out in the swamps. If it can be successfully introduced so as to supersede in part the use of the smaller ditches, a gain in land area and in convenience of cultivation and in the effective draining and aeration of the soil would be the result. By proper care in protecting the joints, it is improbable that silting of the tile would give much trouble.

As a general thing, the water table of the plantations in southern Louisiana is carried at from 1½ to 3 feet beneath the surface, and it is well known that the greater depth is preferable, as, besides furnishing a greater depth for the roots of the growing crop, it also furnishes greater reservoir capacity in the soil to provide against excessive rainfall. It likewise makes possible a smaller pumping equipment. By keeping the pumps running during the winter season, when necessary, the water table is kept as low as possible, aeration of the soil takes place, and the soil is thus put in good physical condition.

PUMPING PLANTS.

Some plantations are so situated that fairly satisfactory drainage can be secured by the installation of outlet gates through the levees, either automatic or hand regulated. These drain the system of reservoirs and ditches in times of sufficiently low water, but when the water outside the levees is higher than the outlet, of course the gates must be closed and the reservoirs depended upon to hold all the interior drainage water. A great majority, however, of the plantations which are reclaimed require the installation of a pumping plant in order to make the drainage system effective at all times and make the leveed area independent, with the possible exception of seepage, of everything except the rainfall. These pumping equipments vary greatly according to individual opinions and means, but each particular location should be studied carefully in connection with all its surrounding conditions in order to choose an installation whose first

^aU. S. Dept. Agr., Office Expt. Stas. Circ. 74.

cost will be warranted by the benefits received, and also one the operating expense of which will be reasonable. A balance should also be struck between the economical reservoir capacity and the size of the pumping plant.

In years past a machine that has been greatly in favor, especially upon the sugar plantations, is the drainage wheel. This is made of any desired capacity and may vary in diameter up to perhaps 30 feet, with a width of from 5 to 7 feet. By proper gearing, usually a double reduction, the speed can be regulated to suit the case, but usually a peripheral velocity of 3 to 4 feet per second is maintained. It is probable that a speed of 5 feet is desirable, for, revolving at a greater velocity, the water is liable to be carried over, while with a slower one a portion of the water may flow back into the pit. These wheels are placed at the end of the main ditch, and when not in operation the flood gate in the levee is closed. When the circumference of the wheel fits closely in a smooth pit, with the lift not exceeding one-third the diameter of the wheel, and when running at the proper speed, such a wheel will handle a large quantity of water at a small cost. Although they have been made, ordinarily, by the individual plantation owners and the actual expense of the material and labor of the wheel itself is not excessive, still the large foundations required make them probably more expensive than some of the more modern installations.

Another machine sometimes used is the rotary or chamber-wheel pump. One objection to this form is that for the larger sizes the construction necessitates that the water be lifted about 10 feet, and in case the necessary lift is less than this there is lost work. They are also somewhat expensive and are limited to their normal rated capacities.

The centrifugal pump is especially adapted to varying lifts, for by the use of a discharge pipe whose end is submerged in the out-fall canal or bayou a siphon effect is produced so that the actual head against which the pump is working is simply the difference in elevation between the waters in the reservoir and in the outlet canal. These pumps, on account of the varying speed at which they can be operated, have discharges, for short periods of time, far in excess of their rated capacities, which is especially desirable in cases of excessive rainfalls of short duration. The ordinary type of centrifugal pump, made principally of cast iron, is somewhat used and can be installed with either vertical or horizontal shafts. In the latter case it can be direct-connected with the steam engine.

There is a special form of centrifugal pump particularly adapted to low lifts, that has been in use for a number of years and is doing most satisfactory work on a great many plantations, including three of the experimental tracts. It consists of a wide, submerged im-

PELLER wheel on a vertical shaft driven by belt or rope from the engine. The water rises through the large wooden body of the pump, flowing away through a wide discharge trough. Except the impeller, shaft, bearings, and pulley, the entire machine is of wood. This pump is of large capacity and is perhaps especially adapted to lifts up to 10 feet, although it is claimed that by the use of two or more wheels, set one above the other, water can be pumped against a head of 40 feet. The discharge trough or platform can be placed at any height required. If it is set at high-water mark, however, there would always be some waste of power when the water in the bayou or out-fall canal is less than this height.

As the necessary water lift in the plantations of this section varies from 3 to 10 feet, it is a matter of economy that the pump be chosen which will only raise the water the height that may be necessary at any particular time. This will avoid the necessity of purchasing an engine and boiler of too great capacity. In some plantations that have been visited it has been found that the effective lift was only one-half of the actual lift, which, it will be readily seen, is a great waste of fuel and plant capacity. When open flumes are used, which are placed at the ordinary water level, the water in flood times can be prevented from flowing back by means of flood gates placed in the flume.

As may be noted above in the description of the pumping equipments of the various plantations, the engines and boilers selected vary greatly. They should, however, be chosen with due regard to first cost, capacity, reliability, and economy of operation. On some of the old sugar plantations the condemned boilers from the sugar houses are used, and run at a low pressure. In cases where the plant is only operated a few days in each year the cost of operation is not such a determining feature as when the plants are called on for regular work during each month of the year. In this latter case it will probably pay to put more money into a better plant, including automatic, high-speed engines, feed-water heaters, and other fuel-saving devices. In the former case simple slide-valve engines with any suitable boiler are about all that will be required. A point to be kept in mind is that these plants are usually run by more or less inexperienced labor, and therefore complicated machinery should be avoided. Economy in plant capacity should not, however, prevent the selection of machinery of sufficient size to take care in as short a time as possible of the probable run-off from excessive storms, as upon such drainage depends the success of the plantation.







[illegible]

